Instruction Manual

Tektronix

TDS 310, TDS 320 & TDS 350
Two Channel Oscilloscopes

070-8568-04

Use this manual for TDS 310, TDS 320, and
TDS 350 oscilloscopes with serial numbers
B040100 and above.

Instrument Serial Numbers

Each instrument manufactured by Tektronix has a serial number on a panel insert or tag, or stamped on the chassis. The first letter in the serial number designates the country of manufacture. The last five digits of the serial number are assigned sequentially and are unique to each instrument. Those manufactured in the United States have six unique digits. The country of manufacture is identified as follows:

B010000	Tektronix, Inc., Beaverton, Oregon, USA
E200000	Tektronix United Kingdom, Ltd., London
J300000	Sony/Tektronix, Japan
H700000	Tektronix Holland, NV, Heerenveen, The Netherlands

Instruments manufactured for Tektronix by external vendors outside the United States are assigned a two digit alpha code to identify the country of manufacture (e.g., JP for Japan, HK for Hong Kong, IL for Israel, etc.).

Tektronix, Inc., P.O. Box 500, Beaverton, OR 97077

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Tektronix warrants that this product will be free from defects in materials and workmanship for a period of three (3) years from the date of shipment. If any such product proves defective during this warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the Tektronix service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; or c) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

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German Postal Information

Certificate of the Manufacturer/Importer

We hereby certify that the TDS 310, TDS 320, and TDS 350 Two Channel Oscilloscopes and all factory-installed options complies with the RF Interference Suppression requirements of Postal Regulation Vfg. 243/1991, Amended per Vfg. 46/1992

The German Postal Service was notified that the equipment is being marketed.

The German Postal Service has the right to re-test the series and to verify that it complies.

TEKTRONIX

Bescheinigung des Herstellers/Importeurs

Hiermit wird bescheinigt, daß der/die/das TDS 310, TDS 320, and TDS 350 Two Channel Oscilloscopes und alle fabrikinstallierten Optionen in Übereinstimmung mit den Bestimmungen der Amtsblatt-Verfügung Vfg. 243/1991 und Zusatzverfügung 46/1992 funkentstört sind.

Der Deutschen Bundespost wurde das Inverkehrbringen dieses Gerätes angezeigt und die Berechtigung zur Überprüfung der Serie auf Einhalten der Bestimmungen eingeräumt.

TEKTRONIX

NOTICE to the user/operator:

The German Postal Service requires that Systems assembled by the operator/user of this instrument must also comply with Postal Regulation, Vfg. 243/1991, Par. 2, Sect. 1.

HINWEIS für den Benutzer/Betreiber:

Die vom Betreiber zusammengestellte Anlage, innerhalb derer dieses Gerät eingesetzt wird, muß ebenfalls den Voraussetzungen nach Par. 2, Ziff. 1 der Vfg. 243/1991, genügen.

NOTICE to the user/operator:

The German Postal Service requires that this equipment, when used in a test setup, may only be operated if the requirements of Postal Regulation, Vfg. 243/1991, Par. 2, Sect. 1.8.1 are complied with.

HINWEIS für den Benutzer/Betreiber:

Dieses Gerät darf in Meßaufbauten nur betrieben werden, wenn die Voraussetzungen des Par. 2, Ziff. 1. 8.1 der Vfg. 243/1991 eingehalten werden.

Tektronix

EC Declaration of Conformity

We

Tektronix Holland N.V.
Marktweg 73A
8444 AB Heerenveen
The Netherlands

declare under sole responsibility that the

TDS 310 Digitizing Oscilloscope

meets the intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the official Journal of the European Communities:

EN 50081−1 Emissions:

EN 55022	Radiated, Class B
EN 55022	Conducted, Class B
EN 60555-2	Power Harmonics

EN 50082−1 Immunity:

IEC 801−2	Electrostatic Discharge
IEC 801−3	RF Radiated
IEC 801−4	Fast Transients
IEC 801−5	Surge

Tektronix

EC Declaration of Conformity

We

Tektronix Holland N.V.
Marktweg 73A
8444 AB Heerenveen
The Netherlands

declare under sole responsibility that the

TDS 320 Digitizing Oscilloscope

meets the intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the official Journal of the European Communities:

EN 50081−1 Emissions:

EN 55022	Radiated, Class B
EN 55022	Conducted, Class B
EN 60555-2	Power Harmonics

EN 50082−1 Immunity:

IEC 801−2	Electrostatic Discharge
IEC 801−3	RF Radiated
IEC 801−4	Fast Transients
IEC 801−5	Surge

Tektronix

EC Declaration of Conformity

We

Tektronix Holland N.V.
Marktweg 73A
8444 AB Heerenveen
The Netherlands

declare under sole responsibility that the

TDS 350 Digitizing Oscilloscope

meets the intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the official Journal of the European Communities:

EN 50081−1 Emissions:

EN 55022	Radiated, Class B
EN 55022	Conducted, Class B
EN 60555-2	Power Harmonics

EN 50082−1 Immunity:

IEC 801−2	Electrostatic Discharge
IEC 801−3	RF Radiated
IEC 801−4	Fast Transients
IEC 801−5	Surge

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Safety Summary

Please take a moment to review these safety precautions. They are provided for your protection and to prevent damage to the oscilloscope. This safety information applies to all operators and service personnel.

Symbols and Terms

These two terms appear in manuals:

- CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.
- WARNING statements identify conditions or practices that could result in personal injury or loss of life.

These two terms appear on equipment:

- *CAUTION* indicates a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property including the equipment itself.
- *DANGER* indicates a personal injury hazard immediately accessible as one reads the marking.

This symbol appears in manuals:



Static-Sensitive Devices

These symbols appear on equipment:



DANGER
High Voltage



Protective
ground (earth)
terminal



ATTENTION
Refer to
manual

Specific Precautions

Observe all the following precautions to ensure your personal safety and to prevent damage to either the oscilloscope or equipment connected to it.

Power Source

The oscilloscope operates from a power source that will not apply more than 250 V_{RMS} between the supply conductors or between either supply conductor and ground. A protective ground connection, through the grounding conductor in the power cord, is essential for safe system operation.

Grounding the Oscilloscope

The oscilloscope is grounded through the power cord. To avoid electric shock, plug the power cord into a properly wired receptacle with an earth ground connection. Do this before making connections to the input or output terminals of the oscilloscope.

Without the protective ground connection, all parts of the oscilloscope are potential shock hazards. This includes knobs and controls that may appear to be insulators.

Use the Proper Power Cord

Use only the power cord and connector specified for your product. Use only a power cord that is in good condition.

Use the Proper Fuse

To avoid fire hazard, use only a fuse that meets all type, voltage, and current specifications on page 2-1.

Do Not Remove Covers or Panels

To avoid personal injury, do not operate the oscilloscope without the panels or covers.

Do Not Operate in Explosive Atmospheres

The oscilloscope provides no explosion protection from static discharges or arcing components. Do not operate the oscilloscope in an atmosphere of explosive gasses.

Electric Overload

Never apply a voltage to a connector on the oscilloscope that is outside the range specified for that connector.

Service Safety Summary

Only qualified personnel should perform service procedures. This safety information applies to all service personnel.

Do Not Perform Service While Alone

Do not perform internal service or adjustment of this product unless another person capable of rendering first aid and resuscitation is present.

Use Care When Servicing With Power On

Dangerous voltages exist at several points in this product. To avoid personal injury, do not touch exposed connections or components while power is on. Disconnect power before removing protective panels, soldering, or replacing components.

Disconnect Power

To avoid electric shock, disconnect the main power by means of the power cord or, if provided, the power switch.

Use Caution When Servicing the CRT

To avoid electric shock or injury, use extreme caution when handling the CRT. Only qualified personnel familiar with CRT servicing procedures and precautions should remove or install the CRT.

CRTs retain hazardous voltages for long periods of time after power is turned off. Before attempting any servicing, discharge the CRT by shorting the anode to chassis ground. When discharging the CRT, connect the discharge path to ground and then the anode. Rough handling may cause the CRT to implode. Do not nick or scratch the glass or subject it to undue pressure when removing or installing it. When handling the CRT, wear safety goggles and heavy gloves for protection.

X-Radiation

To avoid x-radiation exposure, do not modify or otherwise alter the high-voltage circuitry or the CRT enclosure. X-ray emissions generated within this product have been sufficiently shielded.

Preface

The Instruction Manual for the TDS 310, TDS 320, and TDS 350 Two Channel Oscilloscopes provides both user and module-level service information.

The following sections are for users.

- *Introduction* contains a brief product description and an options and accessories list.
- *Getting Started* contains installation, user interface, probe, and autoset information.
- *Operation* contains front panel, rear panel, and menu maps, as well as task-oriented descriptions of oscilloscope features. The descriptions are ordered from least to most complex.
- *Specifications* contains typical, nominal, and warranted specifications for the TDS 310, TDS 320, and TDS 350 Two Channel Oscilloscopes.

The following sections are for qualified service personnel only.

- *Theory of Operation* provides a module-level description of oscilloscope circuitry.
- *Performance Verification* contains procedures you can use to verify that TDS 310, TDS 320, and TDS 350 Two Channel Oscilloscopes are operating within warranted specifications.
- *Adjustment* contains procedures you can use to make internal adjustments after servicing your instrument or moving it to a new operating environment.
- *Maintenance* contains procedures for inspecting and cleaning, troubleshooting, and removing and replacing faulty modules.
- *Parts List* contains a module-level parts list for the TDS 310, TDS 320, and TDS 350.

The following sections are for all users.

- *Glossary* contains a glossary of terms.
- *Index* contains a full index.

NOTE

If you are a novice oscilloscope user, you should read the XYZs of Analog and Digital Oscilloscopes *before using this manual.*

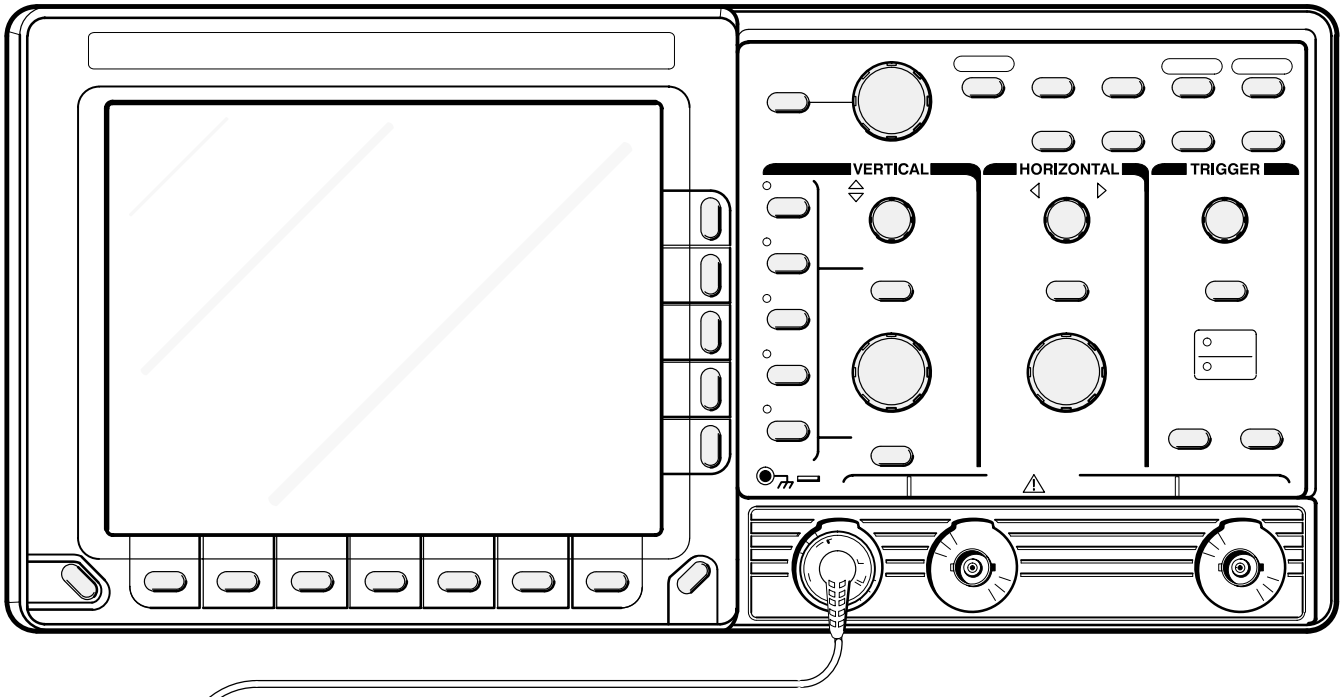
Related Manuals

These other manuals are available for the TDS 310, TDS 320, and TDS 350 Two Channel Oscilloscopes.

- The *Reference* gives you a quick overview of how to operate your oscilloscope.
- *The XYZ's of Analog and Digital Oscilloscopes* provides introductory instruction on basic oscilloscope theory.
- The *Programmer Manual* provides complete information on programming and remote control of the TDS 310, TDS 320, and TDS 350 Two Channel Oscilloscopes through the Option 14 Communications Board.

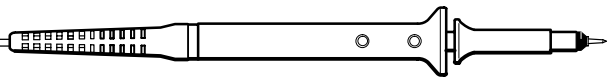
Introduction

Product Description



Tektronix TDS 310, TDS 320, and TDS 350 two channel oscilloscopes are digital signal processors and are superb tools for displaying and measuring waveforms. Their performance addresses the needs of both benchtop lab and portable applications with the following features.

- Two input channels, each with a record length of 1,000 samples and 8-bit vertical resolution. Both channels acquire waveforms simultaneously.
- 1 Gigasample/second maximum sample rate (TDS 350); 500 Megasamples/second maximum sample rate (TDS 320); 200 Megasamples/second maximum sample rate (TDS 310).
- 200 MHz analog bandwidth and fastest time base setting of 2.5 ns/div (TDS 350); 100 MHz analog bandwidth and fastest time base setting of 5 ns/div (TDS 320); 50 MHz analog bandwidth and fastest time base setting of 10 ns/div (TDS 310).
- A full complement of advanced functions including on-screen readout, AUTOSET, cursors, and continuously-updated automatic measurements.
- Waveform averaging, waveform enveloping, and hardware peak detection.
- A unique graphical user interface (GUI) and a logical front-panel layout which combine to deliver the standard in usability pioneered by the TDS family of oscilloscopes.



Options and Accessories

This section describes the various options as well as the standard and optional accessories that are available for the TDS 310, TDS 320, and TDS 350.

Options

Options include the following.

Option 14: I/O Interfaces

This option includes GPIB, RS-232, and Centronics interfaces, VGA video output, and power for the Option 3P printer. It also includes the *TDS 310, 320 & 350 Programmer Manual*.

You can connect a remote display to the VGA 9-pin D connector on the rear panel. Table 1-6 on page 1-6 gives the part number of a properly shielded cable that is commercially available.

Because display manufacturers use different pin combinations and connectors, you may find the information in Table 1-1 helpful.

Table 1-1: VGA Output Connector Pins

Pin	Signal
2	Video (monochrome analog)
4	Horizontal sync @ 31.5 kHz (VGA rate)
5	Vertical sync
6, 7, 8	Ground

Options A1 – A5: International Power Cords

Besides the standard North American, 110 V, 60 Hz power cord, Tektronix ships any of five alternate power cord configurations with the oscilloscope when ordered by the customer (see Table 1-2).

Table 1-2: International Power Cords

Option	Power Cord
A1	Universal European — 220 V, 50 Hz
A2	UK — 240 V, 50 Hz
A3	Australian — 240 V, 50 Hz
A4	North American — 240 V, 60 Hz

Table 1-2: International Power Cords (Cont.)

Option	Power Cord
A5	Switzerland — 220 V, 50 Hz

Option 1K: K212 Scope Cart

With this option, the oscilloscope comes with a K212 Portable Instrument Cart.

Option 3P: Thermal Printer (Includes Option 14)

The instrument comes with a thermal printer connected to the Centronics port. Also included are a carrying pouch that fastens to the top of the oscilloscope and printer instructions.

Option 9C: Certificate of Calibration and Test Data Report

Tektronix ships a Certificate of Calibration that states this instrument meets or exceeds all warranted specifications and has been calibrated using standards and instruments whose accuracies are traceable to the National Institute of Standards and Technology, an accepted value of a natural physical constant or a ratio calibration technique. The calibration is in compliance with US MIL-STD-45662A. This option also includes a test data report for the instrument.

Warranty-Plus Service Options

The following options add to the services available with the standard warranty. (The standard warranty appears immediately following the title page in this manual.)

- **Option M2:** Tektronix provides three years of warranty plus two years remedial service.
- **Option M3:** Tektronix provides three years of warranty plus two years remedial service and four oscilloscope calibrations.
- **Option M8:** Tektronix provides four calibrations and four performance verifications, one of each in the second through the fifth years of service.

Standard Accessories

The standard accessories listed in Table 1-3 come with the TDS 310, TDS 320, and TDS 350.

Table 1-3: Standard Accessories

Accessory
Reference
Instruction Manual
XYZs of Analog and Digital Oscilloscopes
U.S. Power Cord
Probes (quantity two) P6109B 10X Passive (TDS 310 and TDS 320)
Probes (quantity two) P6111B 10X Passive (TDS 350)

Optional Accessories

You can order the optional accessories listed in Table 1-4.

Table 1-4: Optional Accessories

Accessory		Part Number
Scope Camera		C-9, Option 4, (includes Adapter Hood 016−1154−XX)
Oscilloscope Cart		K212
Rackmount Kit (for field conversion)		016−1166−XX
Soft-Sided Carrying Case		016−1158−XX
Carrying Case		016−0792−XX
Deluxe Transit Case		016−1157−XX
Front Cover		200−3232−XX
Accessories Pouch		016−1159−XX
I/O Interface Field Upgrade Kit		TD3F14A
Time Interval to Voltage Converter (requires TM500/5000 mainframe)		TVC501
Docuwave waveform capture utility software for the PC		S60 DWAV
Printer, bubble-jet, 360 dpi, 83 cps, plain paper		HC 220
Instruction Manual	French German Spanish	070−8070−XX 070−8071−XX 070−8819−XX

Accessory Probes

These are other types of probes you can use with the TDS 310, TDS 320, and TDS 350. You can order thefollowing probes separately:

- P6101B 1X Passive Probe
- P6129B Switchable 1X−10X Passive Probe (not recommended for the TDS 350)
- P6408 TTL Logic Probe
- P6009 High Voltage Probe
- AM503S DC/AC Current Probe System
- P6561 SMT Probe

Accessory Cables

Table 1-5 lists cables you can use with the TDS 310, TDS 320, and TDS 350. You can order them separately.

Table 1-6: Accessory Cables

Software	Part Number
GPIB,1 meter (3.3 feet)	012−0991−01
GPIB, 2 meter (6.6 feet)	012−0991−00
RS-232, 9-pin female to 9-pin female connectors, null modem, 76 inch (for AT style computers)	012−1379−XX
RS-232, 9-pin female to 25-pin female connectors, null modem, 76 inch (for PC style computers)	012−1380−XX
RS-232, 9-pin female to 25-pin male connectors, null modem, 9 feet (for serial interface printers)	012−1298−XX
RS-232, 9-pin female to 25-pin male connectors, 15 feet (for modems)	012−1241−XX
Centronics, 25-pin male to 36-pin Centronics, 2.4 meter (8 feet) (for parallel printer interfaces)	012−1214−XX
NEC® VGA video cable. (Use an appropriate adapter when other than a 9-pin monitor connection is needed.)	73893029

Getting Started

Start Up

To properly install and power on the oscilloscope, perform this procedure.

1. Check that you have the proper electrical connections. The rear label lists power requirements for all possible voltage inputs.
2. Check the fuse to be sure it is the proper type and rating (Figure 2-2). TDS 300 Series oscilloscopes are shipped with a UL-approved fuse installed.

 Fuse specifications are as follows.
 IEC 127: 5 by 20 mm, time-lag, 3.15 A, 250 V
 UL198 G/CSA: 5 by 20 mm, time-lag, 3 A, 250 V
3. Connect the proper power cord from the rear-panel power connector (Figure 2-2) to the power system. Use the power cord clamp to secure the cord to the rear panel.
4. Leave space for cooling. Do this by verifying that the air-intake and exhaust holes on the sides and bottom of the cabinet (where the fan operates) are free of any airflow obstructions. Leave at least 5.1 cm (2 in) free on each side.
5. Press the **ON**/**STBY** button to power-up the oscilloscope.

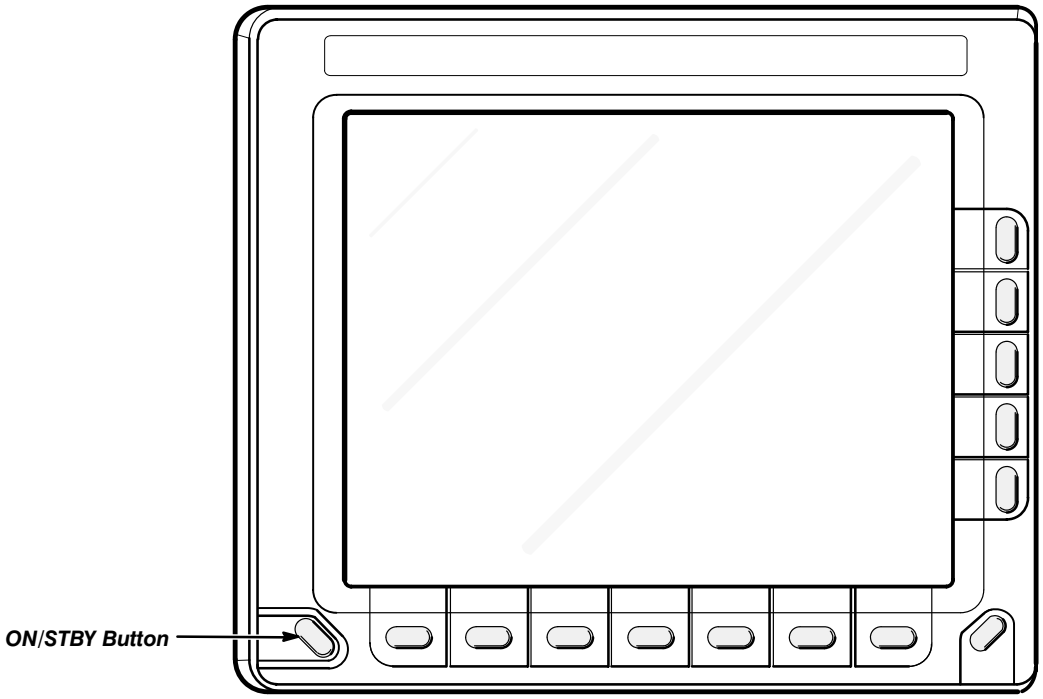


Figure 2-1: ON/STBY Button

Line Fuse Replacement

WARNING

To avoid injury or death, unplug the line cord from the line voltage power source before continuing.

1. Have handy a flat-bladed screwdriver (Item 4).
2. Set the oscilloscope so its bottom is down on the work surface and its rear is facing you.
3. Find the line cord on the rear cover. (See Figure 2-2.) Unplug the line cord from its receptacle.
4. Find the fuse drawer beneath the line voltage plug on the rear panel. Now, pry open the drawer with a small flat-bladed screwdriver (Item 4), and remove the line fuse. (See Figure 2-2.)

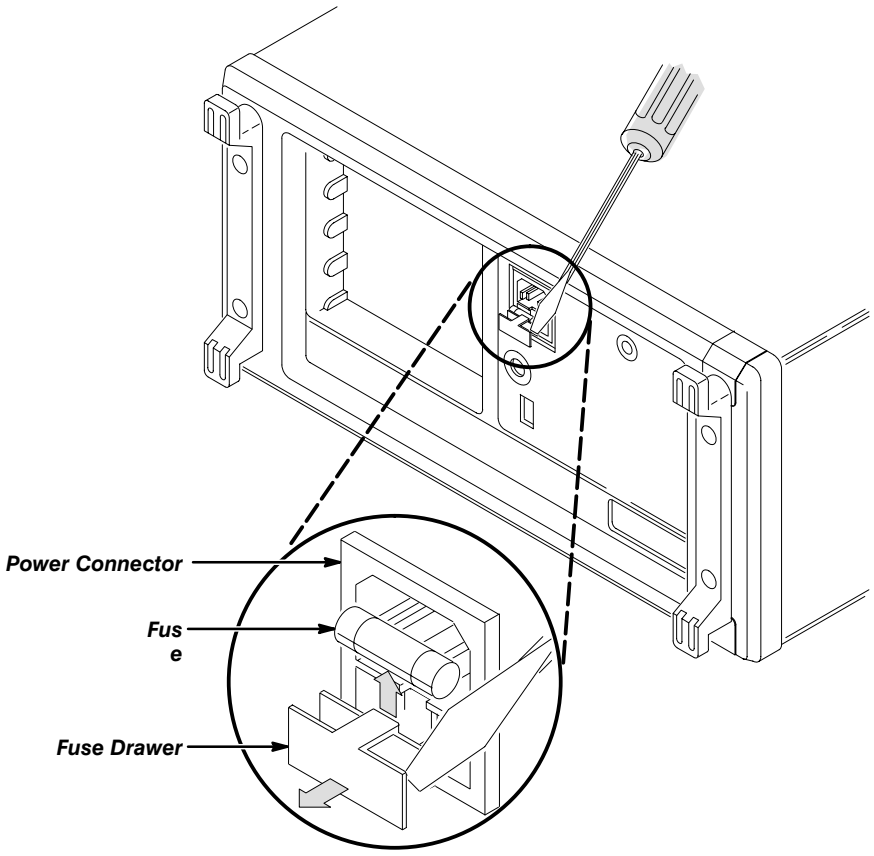


Figure 2-2: Line Fuse Removal

5. *Reinstallation:* Do in reverse steps 6 through 3 to reinstall the line fuse and then the line cord.

Understanding the User Interface

TDS 300 Series oscilloscopes use the TDS Series intuitive user interface. This interface reduces front panel clutter while allowing easy access to specialized functions through the menu structure.

The following procedure illustrates how to navigate in the menu structure. If you are a beginner, you may want to run through it several times to get a feel for how you can access functions and subfunctions. Refer to Figure 2-3 as necessary.

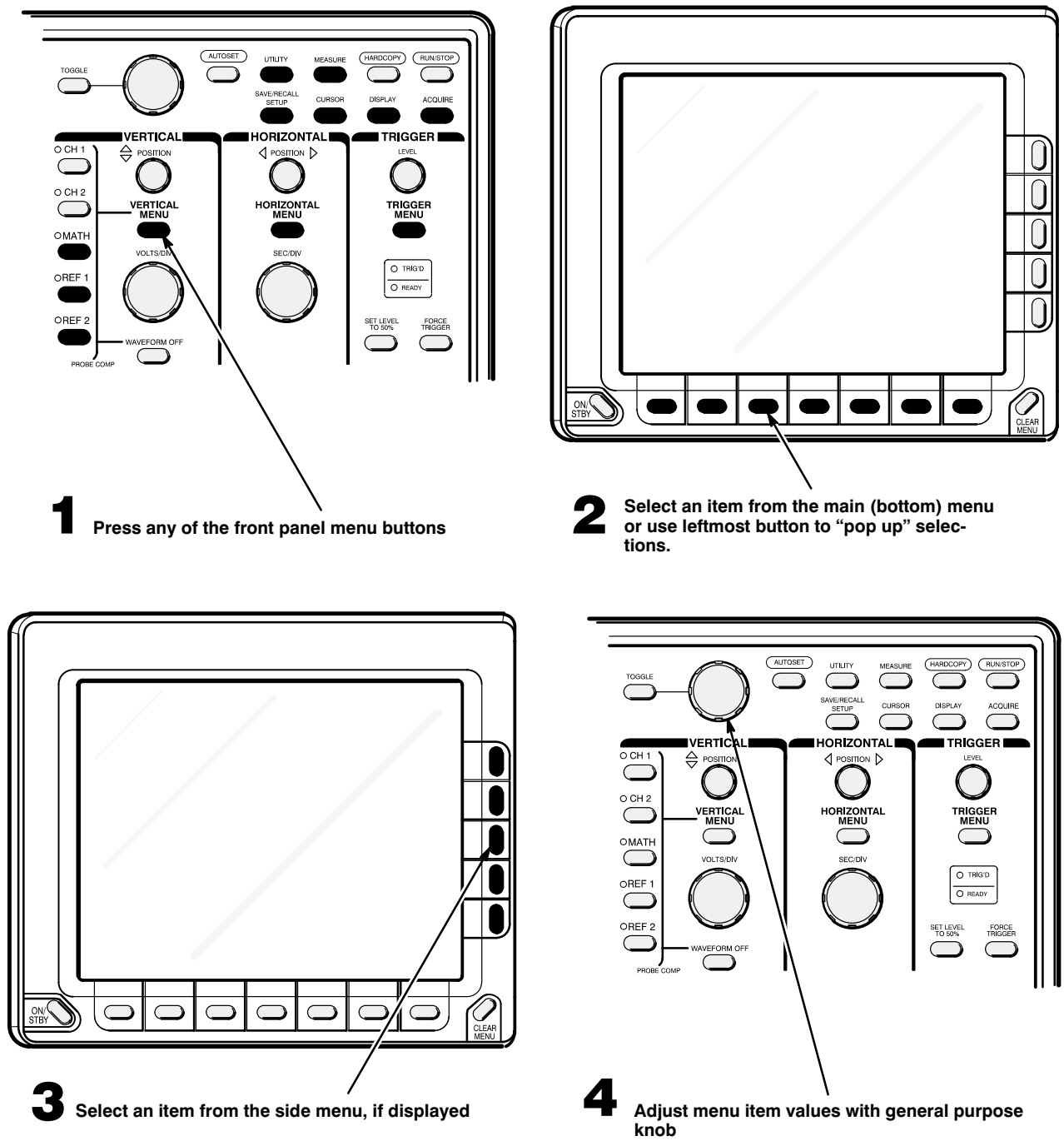


Figure 2-3: Using Menus

1. Push one of the indicated front-panel buttons to call up a menu of functions. This first menu is the *main menu*. Sometimes the main menu will be a side menu (step 3), but most main menus are bottom menus.

2. Push a bottom menu button to select a function. One of three things will happen.
 - If the function has no subfunctions, it becomes active. If it is a variable function, you can now use the **General Purpose Knob** to adjust it (step 4).
 - If the function has subfunctions, they appear on the side menu (step 3).
 - The leftmost bottom menu button sometimes activates a special "pop-up" menu (as shown in Figure 2-4). You can cycle through the pop-up menu options by repeatedly pressing the button. Each selection calls up different bottom and side menus.

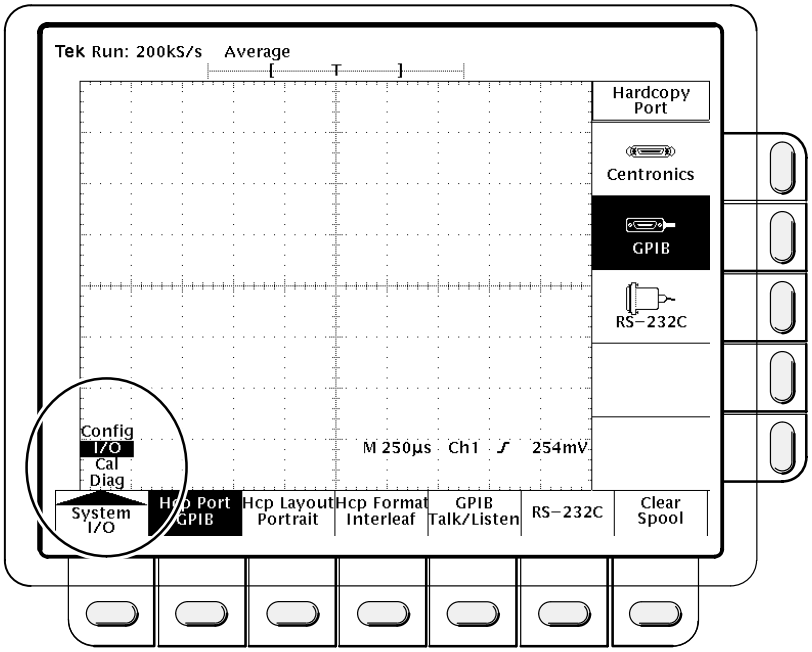


Figure 2-4: A "Pop-Up" Menu

3. Push a side menu button to select a subfunction.
4. Use the **General Purpose Knob** to alter variable function or subfunction settings.
5. Press the **CLEAR MENU** button to remove a menu from the screen.

Using the Probes

The TDS 310, TDS 320, and TDS 350 come with two standard accessory probes. Use these probes to conduct test signals to the oscilloscope. For detailed probe specifications and instructions, see the instruction manual packaged with the probe.

Connecting a Probe

To connect a probe to the oscilloscope, attach the BNC end of the probe to either the **CH 1** or **CH 2** input. Be sure to twist the probe end clockwise until the BNC is fully locked. See Figure 2-5.

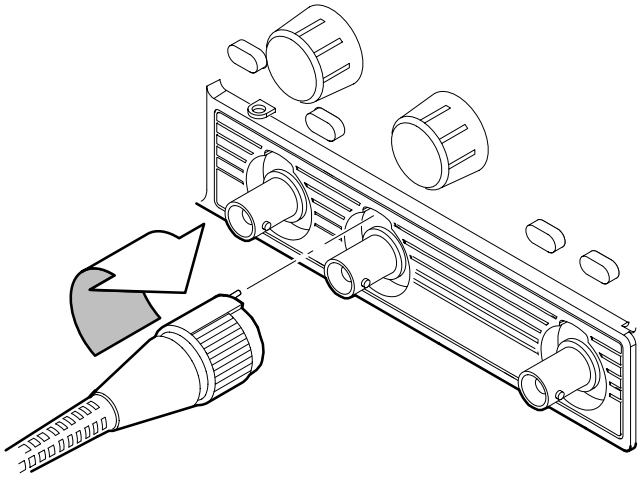


Figure 2-5: Connecting a Probe

Compensating a Probe

Use the following procedure to compensate the probe every time you set up your oscilloscope.

1. Attach the probe BNC connector to the **CH 1** input and attach the probe tip to the **PROBE COMP** output signal, as shown in Figure 2-6. Attach the probe ground clip to the outer ring of the **CH 2** BNC.

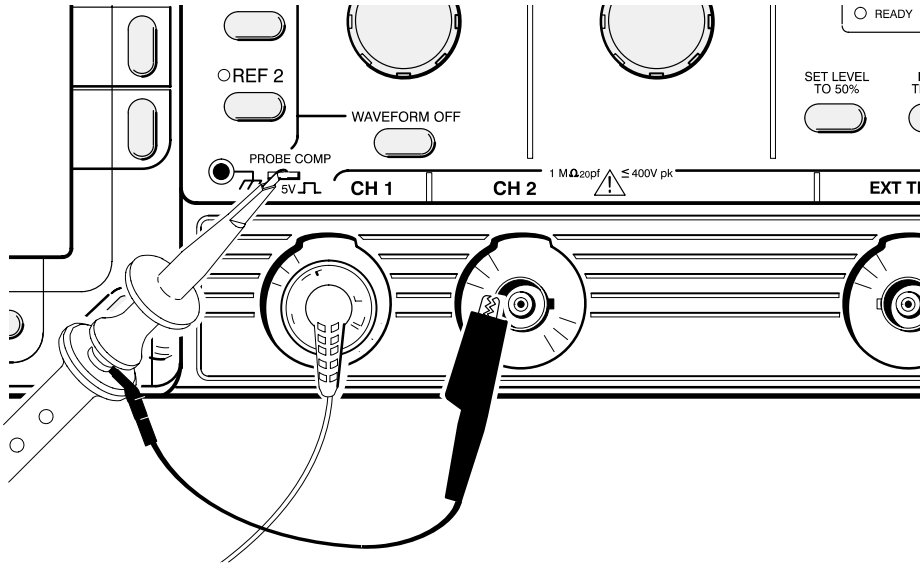


Figure 2-6: Probe Compensation Setup

2. Press **AUTOSET**. The oscilloscope displays the compensation waveform. It should resemble the waveform shown in Figure 2-7.

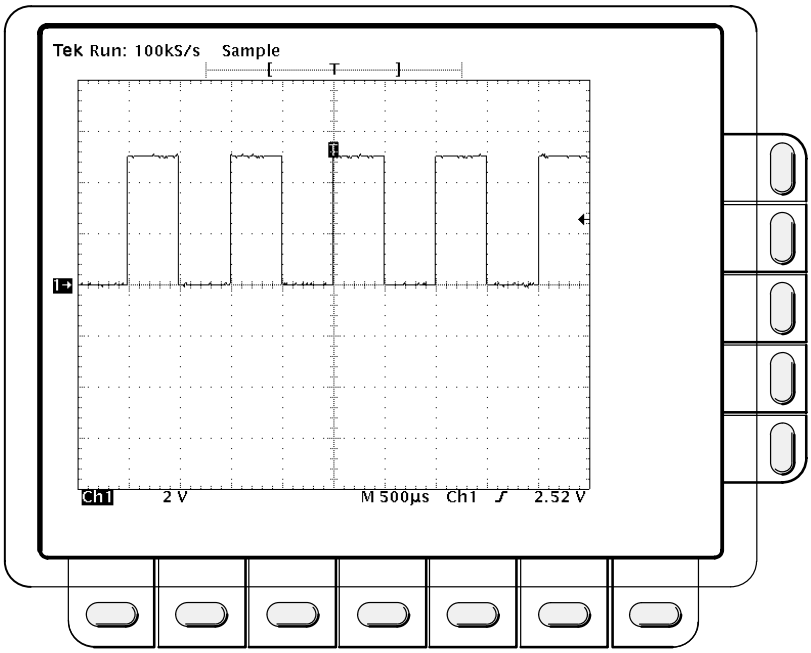


Figure 2-7: Compensation Waveform

3. Check that the waveform indicates correct compensation (see Figure 2-8). If the waveform indicates over or undercompensation, use the alignment tool provided with the probe to adjust the compensation as shown in Figure 2-9.

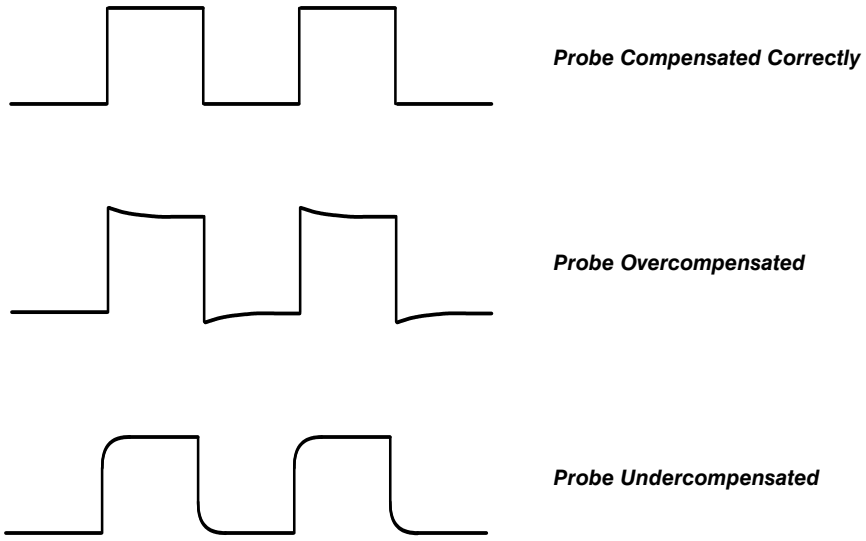


Figure 2-8: How Probe Compensation Affects Signals

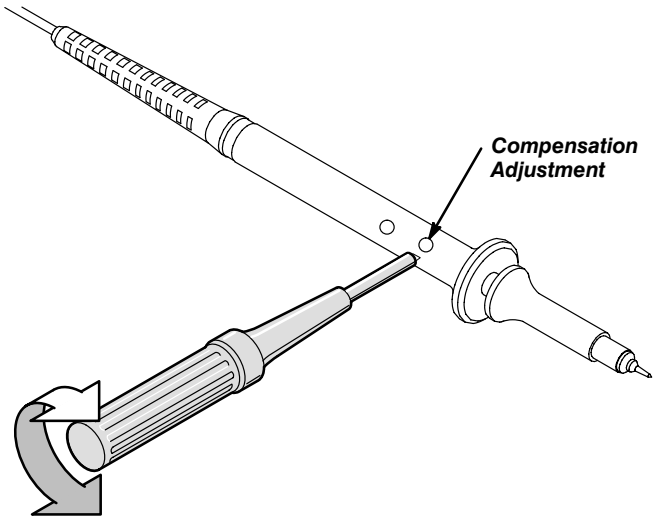


Figure 2-9: Location of Probe Compensation Adjustment

Using Autoset

The TDS 300 Series autoset feature produces a stable, triggered display of almost any input signal. To use autoset, connect a signal to either the **CH 1** or **CH 2** input connector and press the **AUTOSET** button (shown in Figure 2-10).

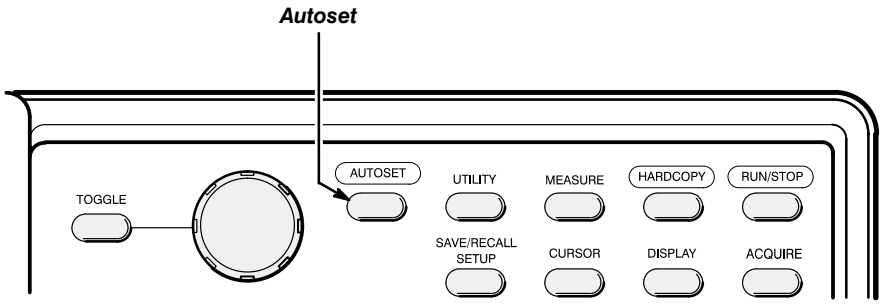


Figure 2-10: The AUTOSET Button

Table 2-1 specifies the changes autoset makes in your instrument setup.

Table 2-1: Autoset Defaults

Control	Changed by Autoset to
Selected channel	If none already displayed, numerically lowest of the displayed channels
Acquire Mode	Sample
Acquire Stop After	RUN/STOP button only
Display Style	Vectors
Display Intensity — Overall	If less than 50%, set to 75%
Display Format	YT
Horizontal Position	Centered within the graticule window
Horizontal Scale	As determined by the signal frequency
Horizontal Time Base	Main Only
Trigger Position	Unchanged
Trigger Type	Edge
Trigger Source	Numerically lowest of the displayed channels (the selected channel)

Table 2-1: Autoset Defaults (Cont.)

Control	Changed by Autoset to
Trigger Level	Midpoint of data for the trigger source
Trigger Slope	Positive
Trigger Coupling	DC
Trigger Holdoff	500 ns
Vertical Scale	As determined by the signal level
Vertical Coupling	DC unless AC was previously set; AC remains unchanged
Vertical Bandwidth	Full
Vertical Offset	0 volts

Operation

Operation

This section describes how to operate your TDS 300 Series oscilloscope. It begins with three instrument-descriptive sections that cover all controls, inputs, and menus.

It then continues on to various task descriptions. The tasks are in a functional order, starting with the most basic (*Manipulating Waveforms*) and then moving to the more specialized (*Making Hardcopies*).

Front Panel

TDS 300 Series oscilloscopes are simple to use. To reduce the clutter of knobs and buttons on the front panel (see Figure 3-1), many instrument control functions are menu driven. Use menus to access instrument functions that you typically set once before making measurements. Use knobs or buttons to control instrument functions that you most often adjust during measurements.

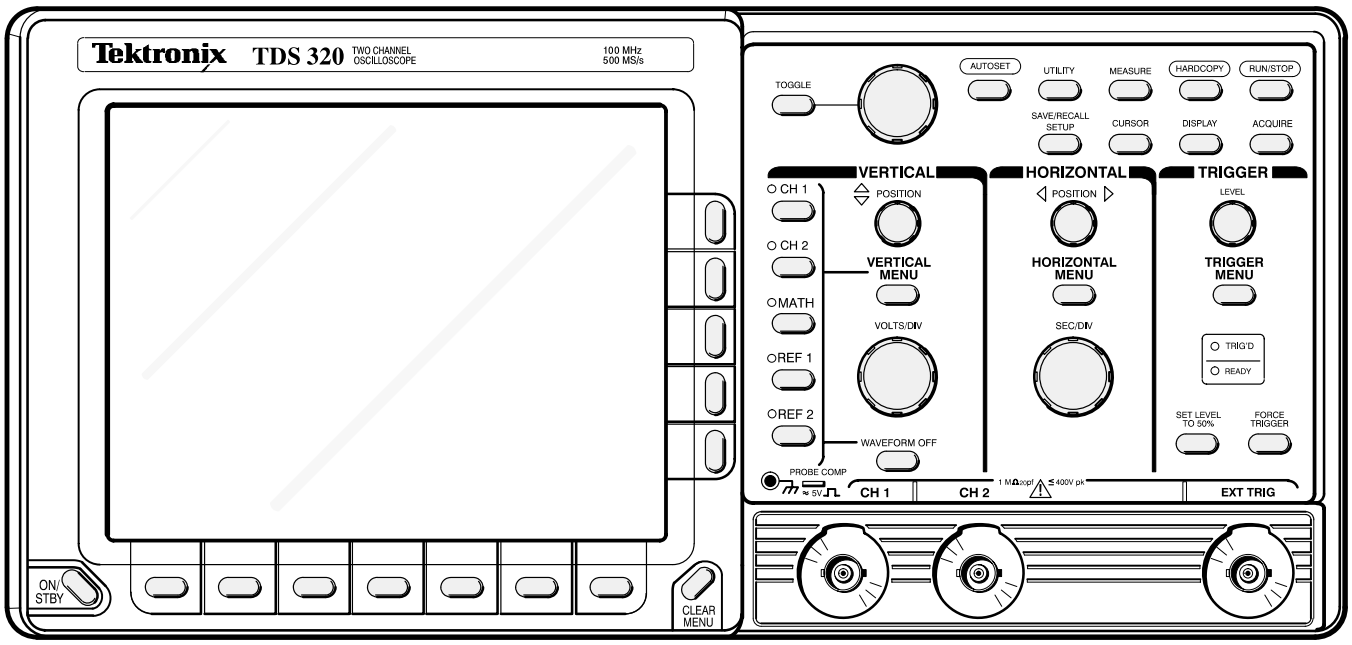
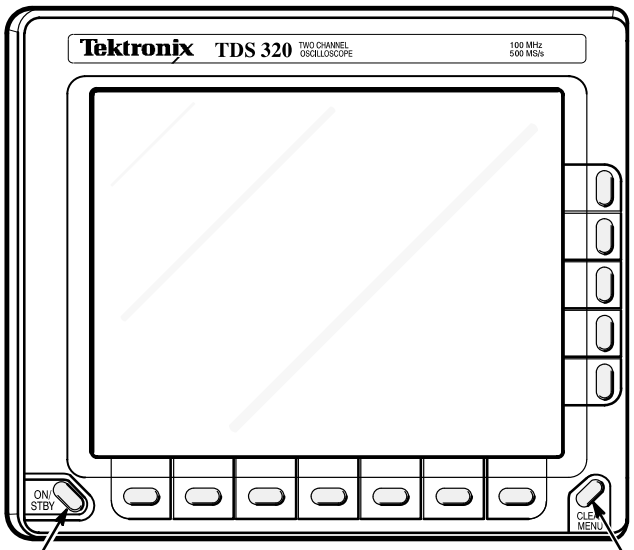


Figure 3-1: The TDS 320 Oscilloscope Front Panel

The menus are easy to use. For example, to make a change to the vertical operating system, press the **VERTICAL MENU** button to display the menu choices.

This section illustrates each control and connector and contains brief descriptions of its use or function.

Display and Power Controls



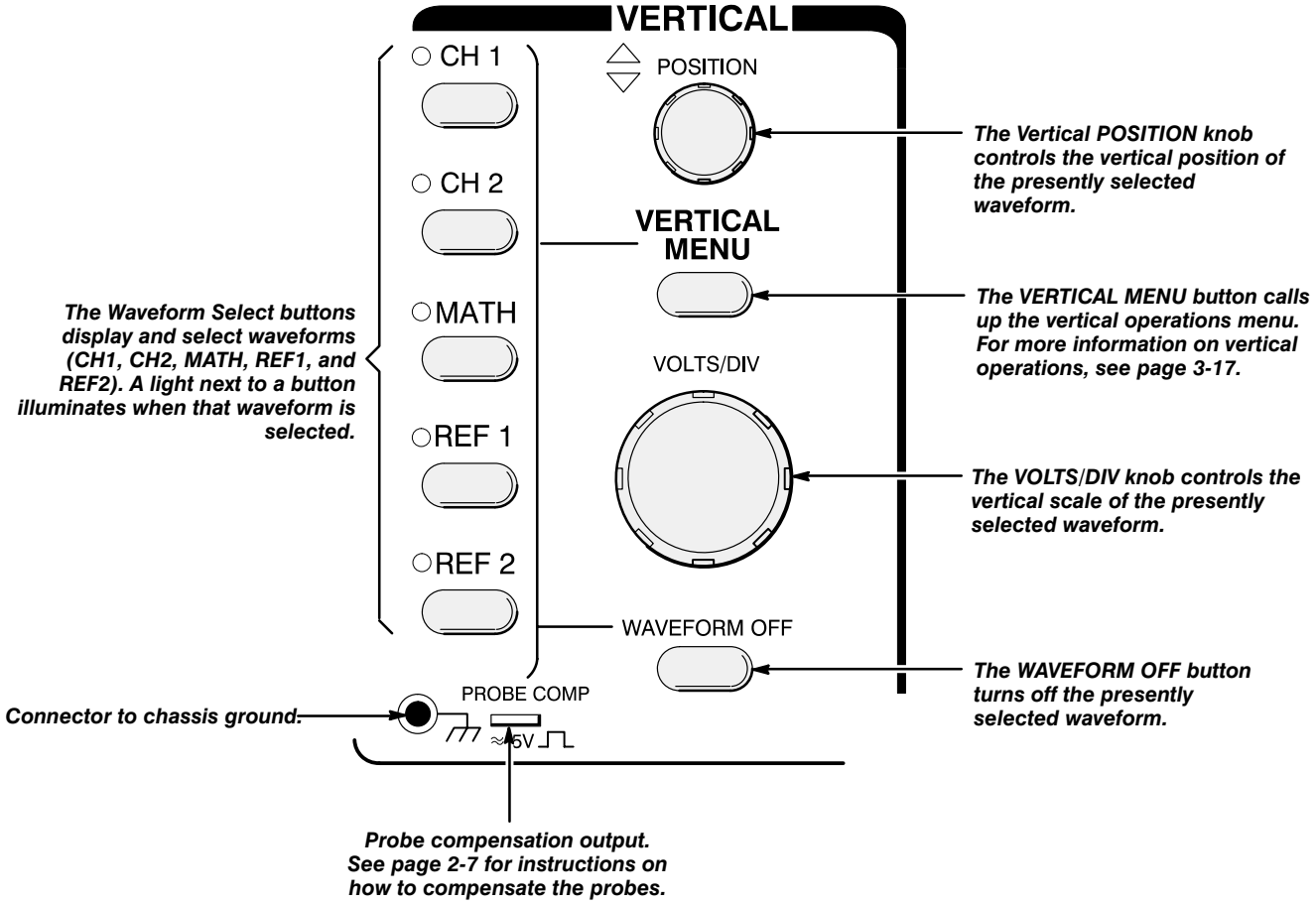
The Side Menu buttons provide access to side menu selections. See page 2-3 for more information on the user interface.

The ON/STBY button toggles instrument power.

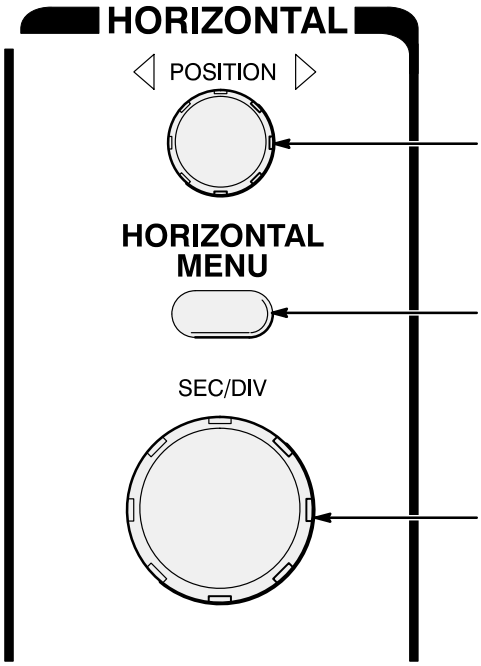
The Main Menu buttons provide access to main menu selections. See page 2-3 for more information on the user interface.

The CLEAR MENU button clears all menus from the screen.

Vertical Controls



Horizontal Controls

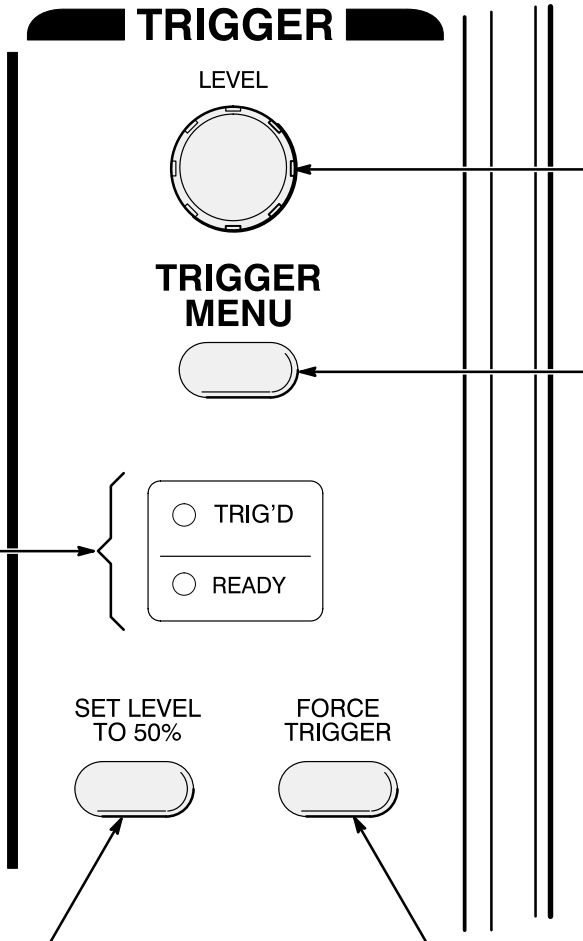


The Horizontal POSITION knob controls the horizontal position of all waveforms.

The HORIZONTAL MENU button calls up the horizontal operations menu. For more information on horizontal operations see page 3-20.

The SEC/DIV knob controls the horizontal scale of the active waveforms.

Trigger Controls



The Trigger LEVEL knob controls the trigger.

The TRIGGER MENU button calls up the trigger menu. See page 3-25 for more information on triggering.

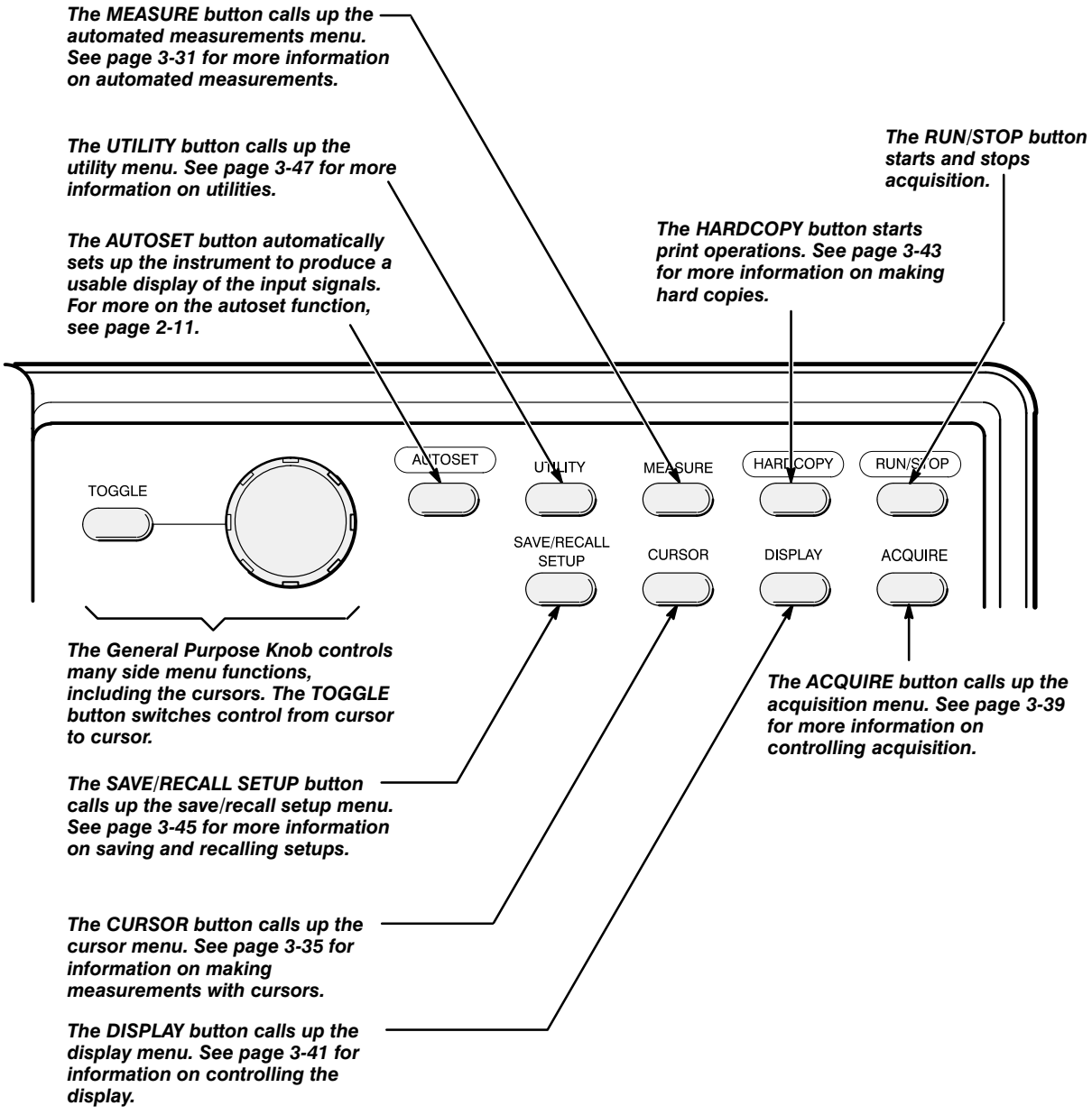
The Trigger Status Lights indicate the status of the triggering system. The TRIG'D light illuminates when the instrument recognizes a valid trigger.

The READY light illuminates when the instrument can accept a valid trigger and is waiting for that event to occur.

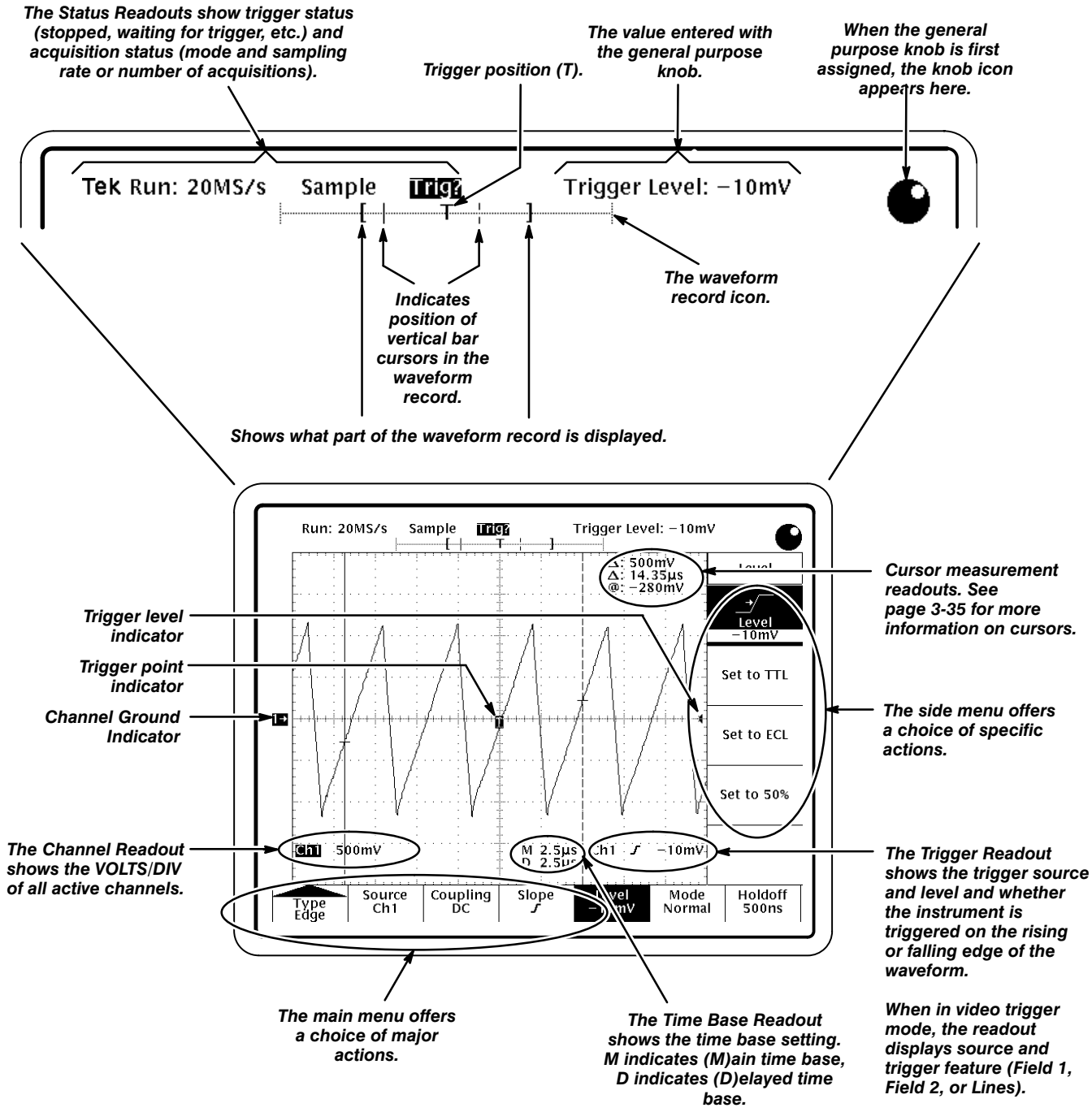
The SET LEVEL TO 50% button sets the trigger level at the half-way point between the peaks of the trigger signal.

The FORCE TRIGGER button forces the oscilloscope to start acquiring a waveform regardless of whether a trigger event occurs. This button has no effect if the acquisition system is stopped.

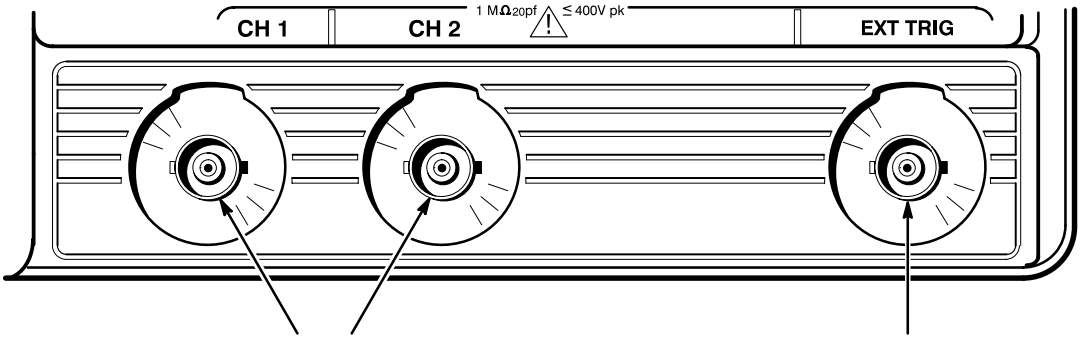
Miscellaneous Controls



Display Map


The Status Readouts show trigger status (stopped, waiting for trigger, etc.) and acquisition status (mode and sampling rate or number of acquisitions).
Trigger position (T).
The value entered with the general purpose knob.
When the general purpose knob is first assigned, the knob icon appears here.
Tek Run: 20MS/s Sample Trig?
Trigger Level: −10mV
The waveform record icon.
Indicates position of vertical bar cursors in the waveform record.
Shows what part of the waveform record is displayed.
Run: 20MS/s Sample Trig?
Trigger Level: −10mV
Δ: 500mV
Δ: 14.35µs
@: −280mV
Level
−10mV
Set to TTL
Set to ECL
Set to 50%
Trigger level indicator
Trigger point indicator
Channel Ground Indicator
Cursor measurement readouts. See page 3-35 for more information on cursors.
The side menu offers a choice of specific actions.
The Channel Readout shows the VOLTS/DIV of all active channels.
Ch1 500mV
M 2.5µs
D 2.5µs
Ch1 ƒ −10mV
The Trigger Readout shows the trigger source and level and whether the instrument is triggered on the rising or falling edge of the waveform.
When in video trigger mode, the readout displays source and trigger feature (Field 1, Field 2, or Lines).
Type Edge
Source Ch1
Coupling DC
Slope ƒ
Mode Normal
Holdoff 500ns
The main menu offers a choice of major actions.
The Time Base Readout shows the time base setting. M indicates (M)ain time base, D indicates (D)elayed time base.

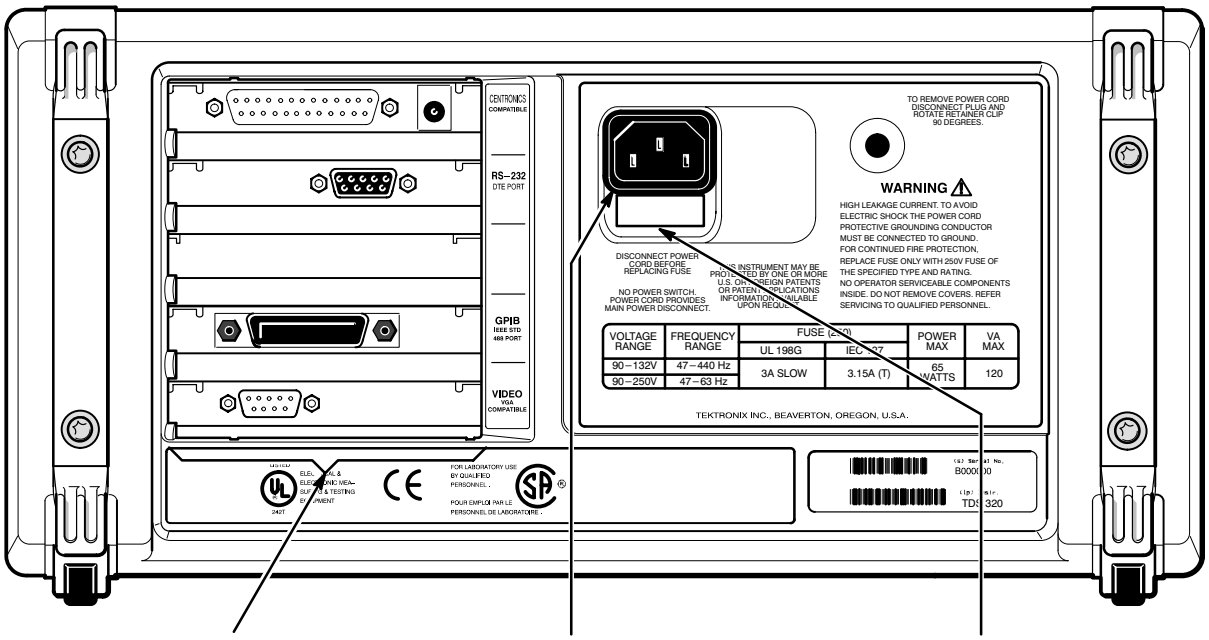
Inputs



The channel BNC inputs (CH1 and CH2) accept electrical signals for display.

The EXT TRIG input accepts external trigger signals. See page 3-26 for more information on external triggering.

Rear Panel



The Option 14 Panel (Option 14 instruments only) allows access to three communications interfaces: a Centronics parallel port, an RS-232 interface, and a GPIB interface. It also includes a VGA video compatible output port and a power connector for the Option 3P printer.

You can use the Centronics, RS-232, and GPIB interfaces to transmit hardcopy data; see page 3-43 for hardcopy procedures.

You can use the GPIB and RS-232 interfaces to operate and program the oscilloscope from a GPIB controller; see the* TDS 310, 320, & 350 Programmer Manual *for more information.

The power connector accepts line voltage to power the instrument. See page 1-3 for a list of power cord and connector options.

The fuse drawer holds the line fuse. See page 8-9 for fuse replacement procedures.

Menu Maps

Most TDS 310, TDS 320, and TDS 350 features are menu driven. This section contains two menu maps: one of the primary functions (vertical, horizontal, and triggering functions) and one of the secondary functions (acquisition functions, utilities, and so on).

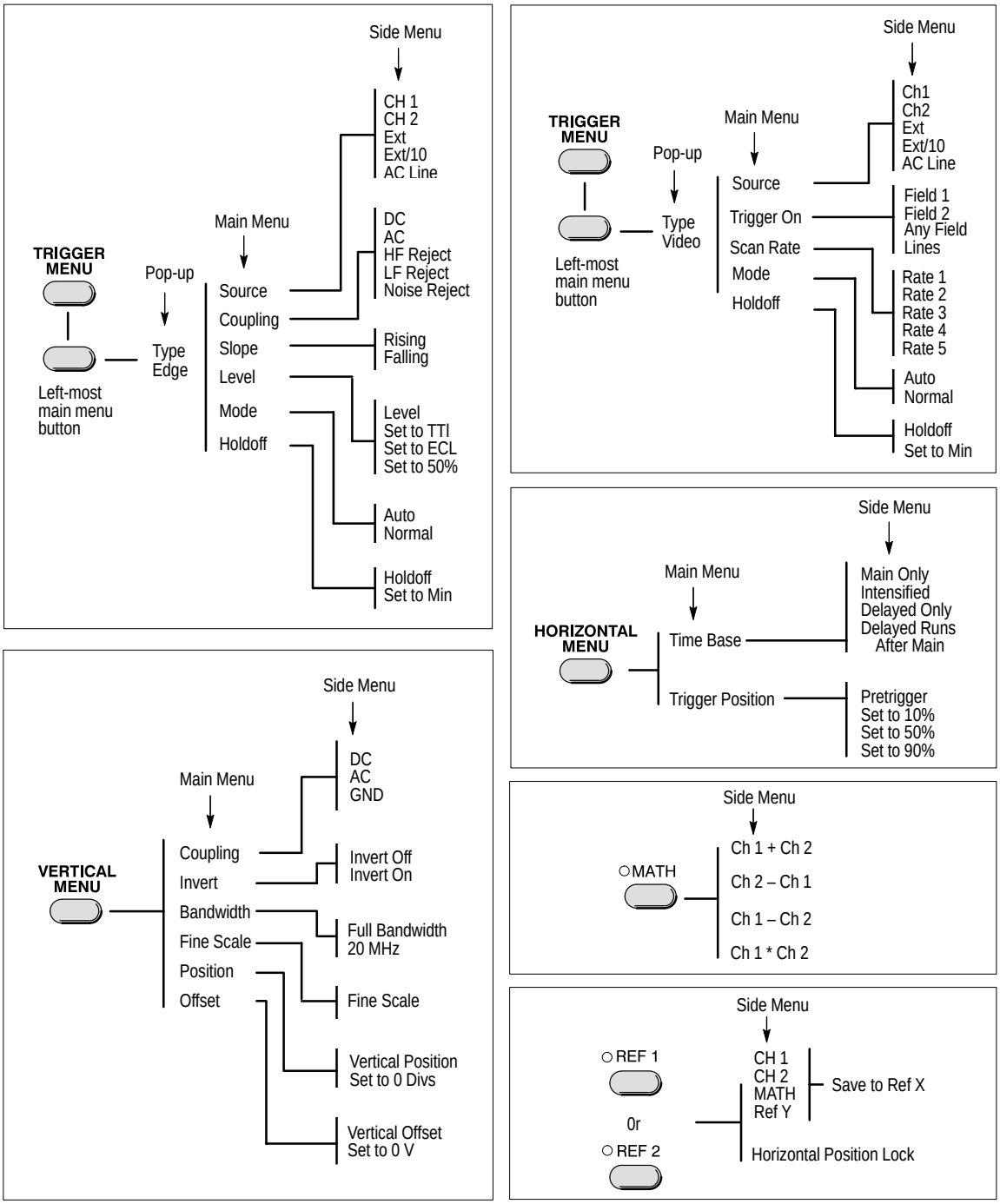


Figure 3-2: Primary Functions Menu Map

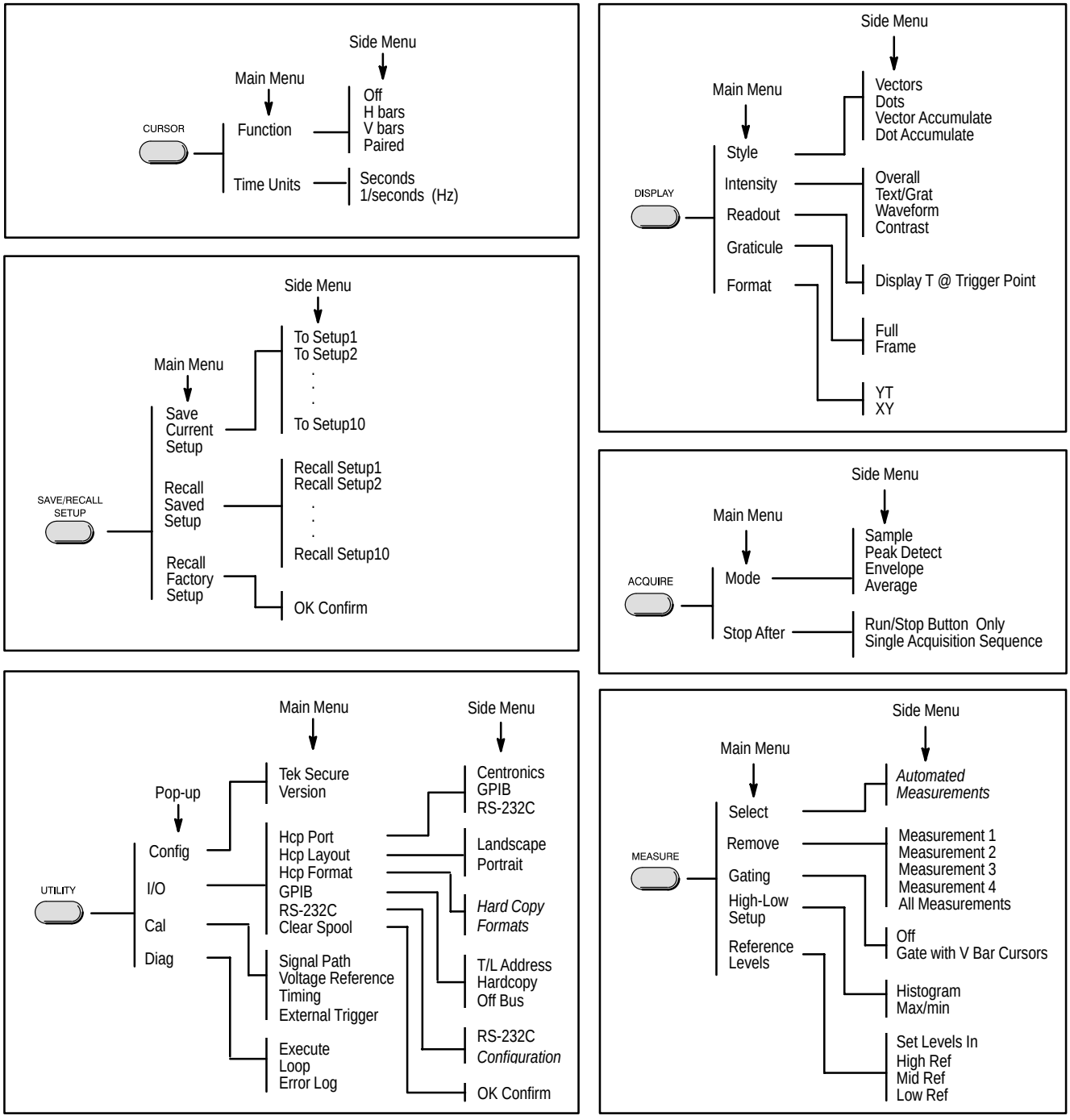


Figure 3-3: Secondary Functions Menu Map

Manipulating Waveforms

There are four basic ways to manipulate waveforms with TDS 300 Series oscilloscopes.

- You can change their display parameters with the vertical and horizontal systems
- You can add, subtract, and multiply them with the waveform math feature
- You can save them to and recall them from reference waveform memories

Vertical Operations

To access the vertical system features, press the **VERTICAL MENU** button, shown in Figure 3-4.

NOTE

*The **VERTICAL MENU** button calls up the vertical menu only if a channel waveform (CH 1 or CH 2) is selected. If a math or reference waveform is selected, the **VERTICAL MENU** button calls up the math or reference waveform menu.*

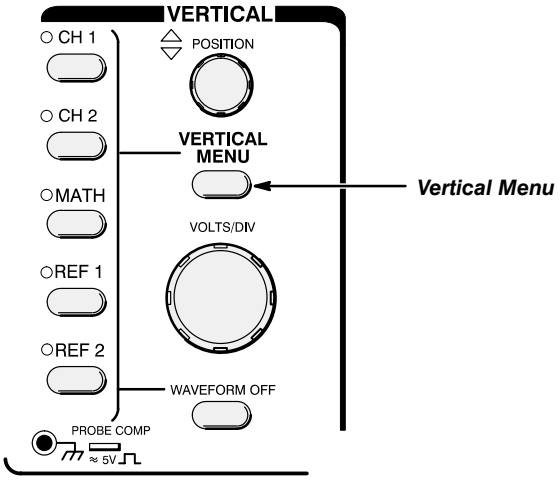


Figure 3-4: The VERTICAL MENU Button

Figure 3-5 shows the vertical menu.

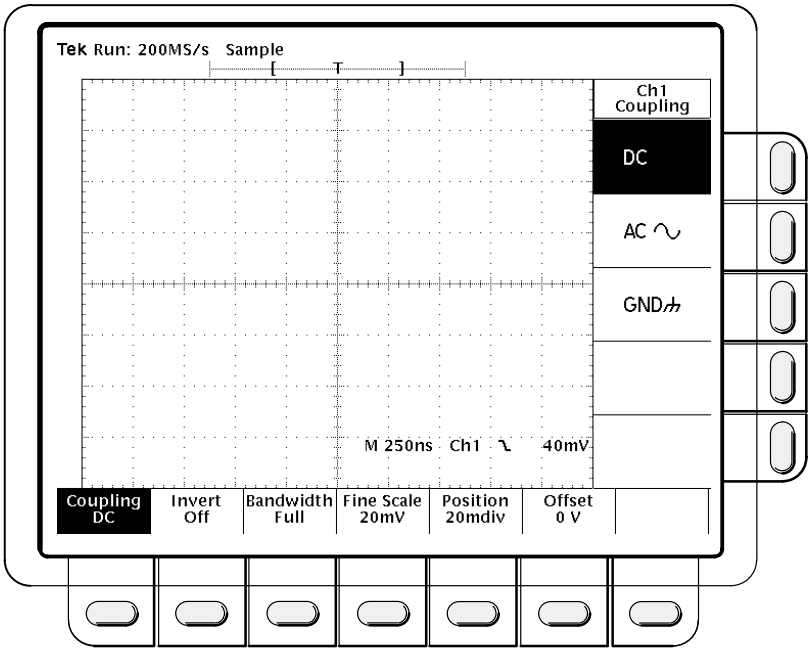


Figure 3-5: The Vertical Menu

Use the vertical menu to perform these tasks.

Select Input Coupling — Press the main menu button **Coupling**. Use the side menu to select **DC**, **AC**, or ground (**GND**) coupling.

Invert a Waveform — Press the main menu button **Invert**. Use the side menu to turn invert off and on. When you turn invert on, the selected waveform "flips" around the zero volt axis. Figure 3-6 shows an inverted pulse signal.

NOTE

Invert "flips" the waveform, but it does not alter the trigger level accordingly. To obtain a stable trigger after inverting a waveform, press ***SET LEVEL TO 50%****.*

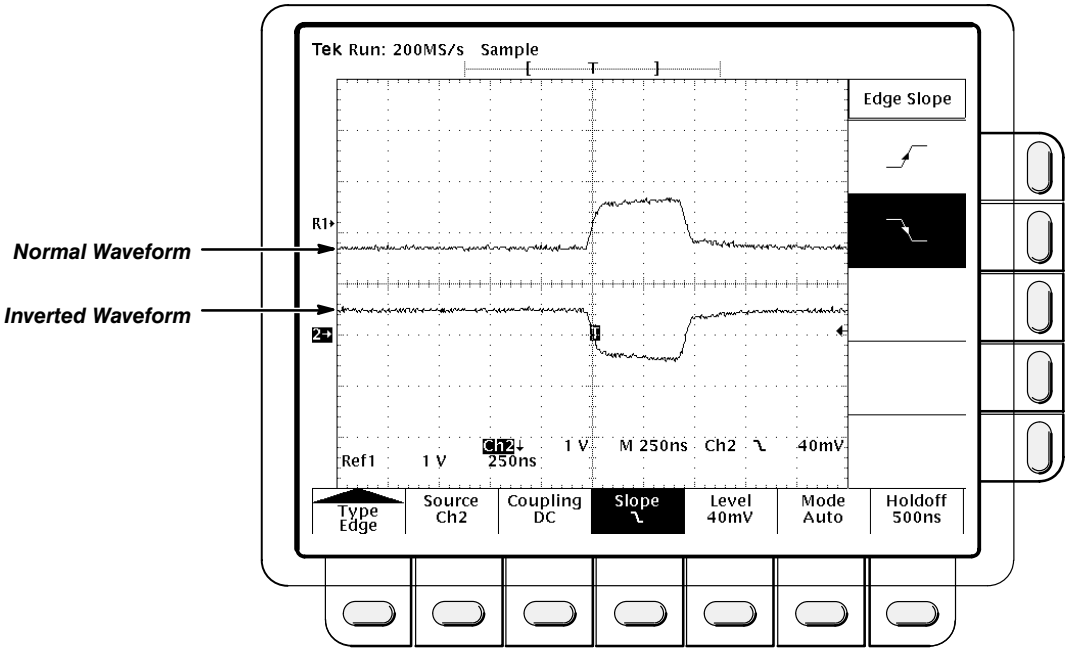


Figure 3-6: Inverting a Waveform

Select Bandwidth — Press the main menu button **Bandwidth**. Use the side menu to switch between 20 MHz and full bandwidth.

Make Fine V/div Adjustments — Press the main menu button **Fine Scale** to activate the **General Purpose Knob**. Then use the knob to make precise adjustments to the vertical scale setting.

Adjust Vertical Position — Press the main menu button **Position** to activate the **General Purpose Knob**. Then, use the knob to adjust vertical position or use the side menu to set the vertical position to 0 divisions. Vertical position is limited to a range of ±5 divisions.

NOTE

*This selection performs the same function as the vertical **POSITION** knob.*

Adjust Vertical Offset — Press the main menu button **Offset** to activate the **General Purpose Knob**. Then use the knob to adjust offset or use the side menu to set the offset to 0 V. Offset performs the same basic function as the vertical **POSITION** knob, but it has a wider range. Use offset to view a waveform that has a large DC bias.

Horizontal Operations

To access horizontal system features, press the **HORIZONTAL MENU** button, shown in Figure 3-7. Figure 3-8 shows the horizontal menu.

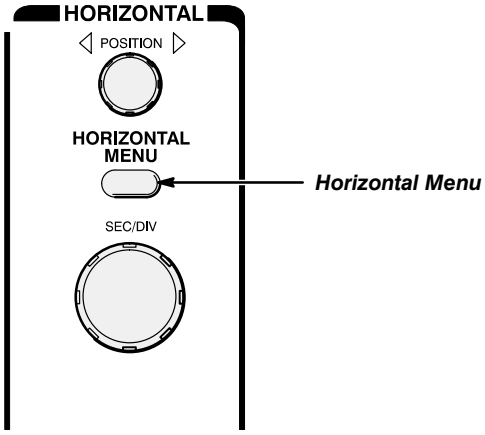


Figure 3-7: The HORIZONTAL MENU Button

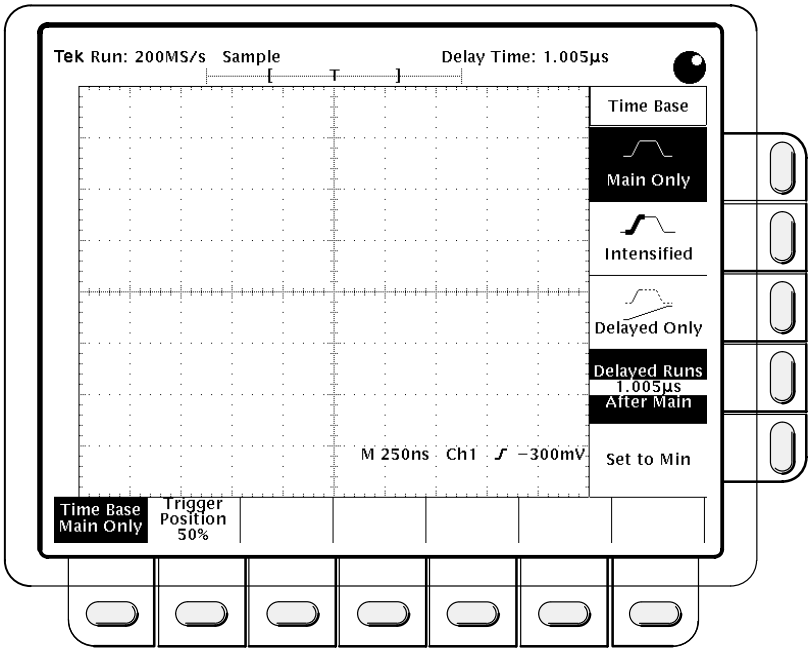


Figure 3-8: The Horizontal Menu

Use the horizontal menu to perform these tasks.

Select the Time Base — Press the main menu button **Time Base**. Use the side menu to select from these options.

- Press **Main Only** to show only the main time base.
- Press **Intensified** to show both the main and delayed time bases. The oscilloscope intensifies a portion of the waveform; this intensified zone indicates the location of the delayed time base with respect to the main. Use the **SEC/DIV** knob to change the length of the zone and the **General Purpose Knob** to change its position.
- Press **Delayed Only** to show only the delayed time base.
- Use the **General Purpose Knob** to adjust the delay time (the interval between the main and delayed time bases). You adjust the delay time in coarse increments when Main Only or Intensified are selected and in fine increments when Delayed Only is selected. The side menu selection **Delayed Runs After Main** shows the delay time.
- Press **SET to Min** to set the delay time to its minimum value.

Adjust Horizontal Trigger Position — Press the main menu button **Trigger Position**. Use the **General Purpose Knob** to adjust horizontal trigger position, or use side menu selections to set the trigger position to 10%, 50%, or 90% of the waveform record.

Displaying Math Waveforms

TDS 300 Series oscilloscopes can add or multiply the two channel waveforms or subtract one from the other and display the result as a math waveform. To activate the math waveform, press the **MATH** button, shown in Figure 3-9.

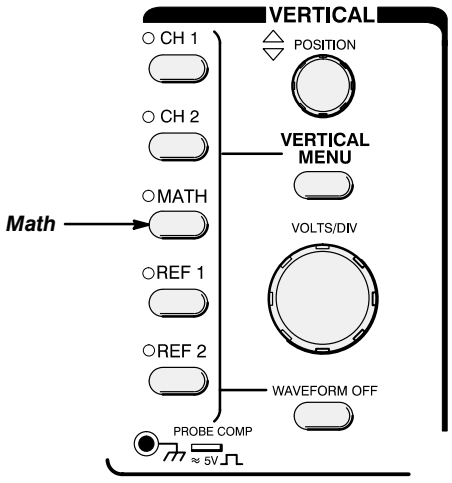


Figure 3-9: The MATH Button

Then select a formula from the side menu (**Ch1 + Ch2**, **Ch1 − Ch2**, **Ch2 − Ch1**, or **CH1 * Ch2**). Figure 3-10 shows a square wave on Channel 2 added to a sine wave on Channel 1.

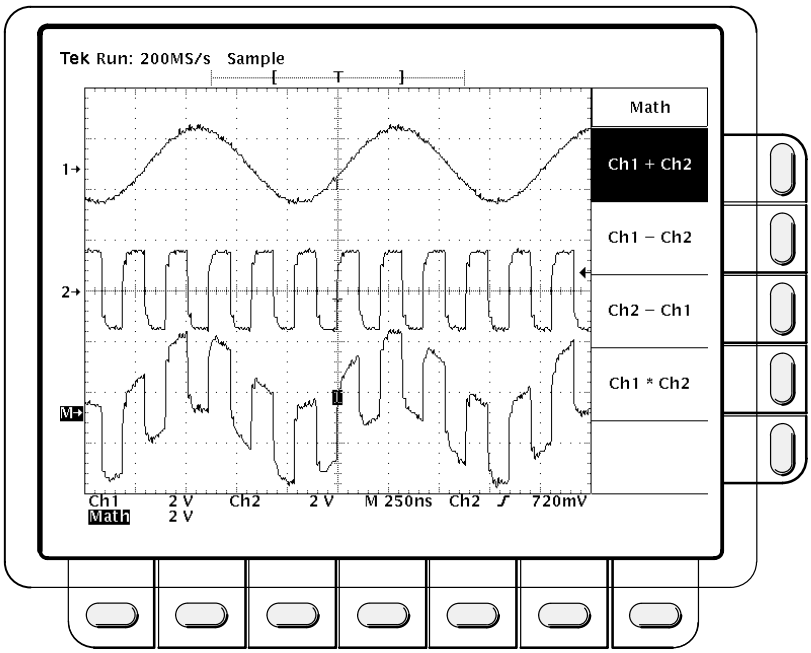


Figure 3-10: A Math Waveform

Saving and Recalling Waveforms

TDS 300 Series oscilloscopes have two reference waveforms. You can use the reference waveforms to store “live” waveforms (channel and math waveforms). You can also shift a stored waveform from one reference waveform to the other.

Reference waveforms respond just like live waveforms to changes in vertical position and scale, but they do not respond to horizontal scale adjustments. There is no way to horizontally expand a reference waveform.

To save a live waveform to a reference waveform, press one of the reference waveform buttons (**REF 1** or **REF 2**) shown in Figure 3-11.

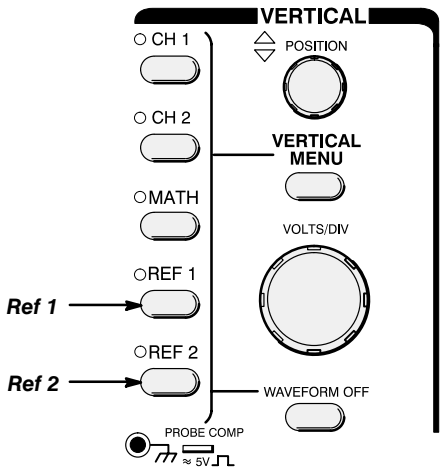


Figure 3-11: The Reference Waveform Buttons

If the selected reference waveform already holds a waveform, it appears on the screen. A side menu also appears; select one of these options from the side menu (see Figure 3-12).

- Press **Save CH1 to Ref(x)** to save the channel 1 waveform to the selected reference waveform.
- Press **Save CH2 to Ref(x)** to save the channel 2 waveform to the selected reference waveform.
- Press **Save MATH to Ref(x)** to save the math waveform to the selected reference waveform.
- Press **Save Ref(y) to Ref(x)** to save the unselected reference waveform to the selected reference waveform. (For example, Ref2 to Ref1 or Ref1 to Ref2.)
- Press **Horizontal Position** to toggle between the Lock and Independent modes. In Lock mode, the horizontal position of the selected reference waveform is locked to the live waveforms. In Independent mode, the selected reference waveform is independently positionable.

NOTE

If you save a waveform to a "full" reference waveform, its previous contents will be overwritten.

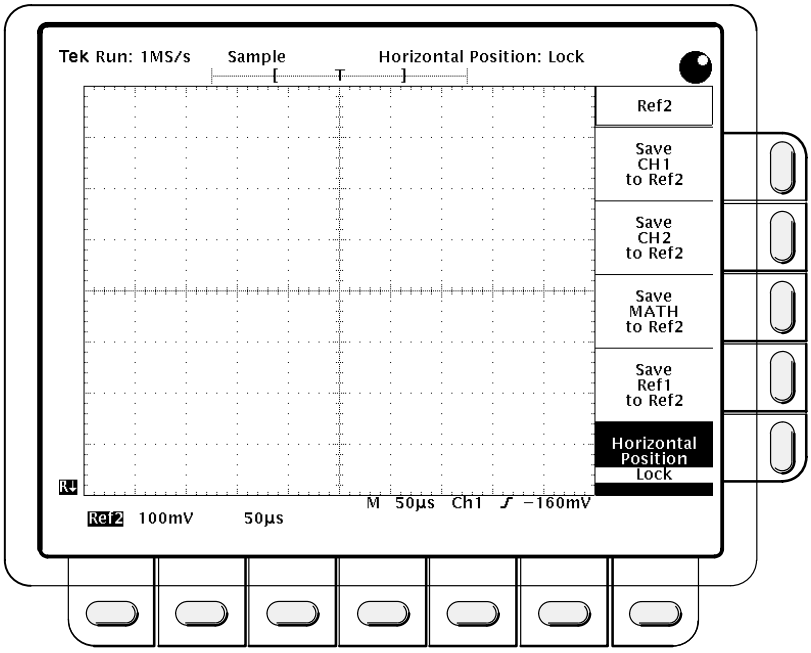


Figure 3-12: A Reference Waveform Menu

The reference waveforms maintain their contents indefinitely, regardless of the power state or setup of the instrument. To remove a selected reference waveform from the display, press **WAVEFORM OFF**. To recall a reference waveform simply press its front panel button (**REF 1** or **REF 2**).

Triggering

TDS 300 Series oscilloscopes have two triggers: a standard edge trigger and a video trigger. To access trigger settings and features, press the **TRIGGER MENU** button, shown in Figure 3-13.

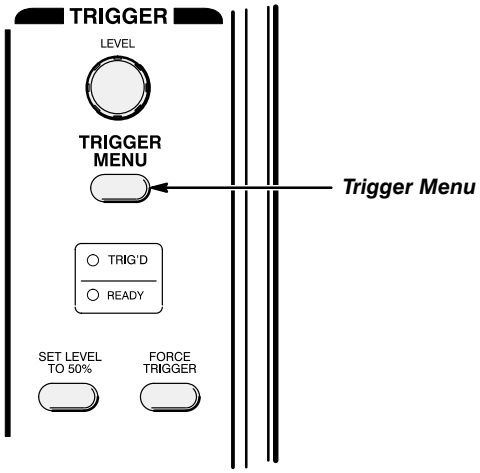


Figure 3-13: The TRIGGER MENU Button

This button calls up one of two menus: the edge trigger menu or the video trigger menu. Press the leftmost main menu button to switch between the two trigger menus.

Edge Triggering

The edge trigger triggers on the rising or falling edge of the input signal. You can access edge trigger settings through the edge trigger menu, shown in Figure 3-14. Be sure the leftmost main menu selection indicates **Type Edge**.

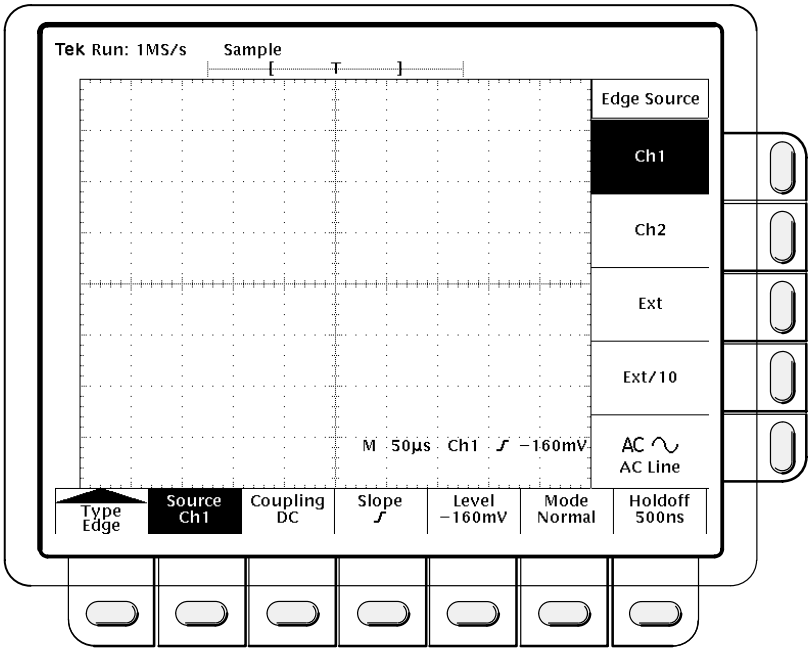


Figure 3-14: The Edge Trigger Menu

Use the edge trigger menu to perform these tasks.

Select the Trigger Source — Press the main menu button **Source**. Use the side menu to select from these options.

- Press **Ch1** or **Ch2** to set the trigger source to one of the input channels.
- Press **Ext** or **Ext/10** to set the trigger source to the **EXT TRIG** input on the front panel. **Ext/10** attenuates the external input signal by a factor of ten. Note that while the instrument can trigger on external trigger signals, it cannot display them.
- Press **AC** to set the trigger source to the oscilloscope line voltage signal.

Select Trigger Coupling — Press the main menu button **Coupling**. Use the side menu to select from these options.

- Press **DC** to select DC coupling.
- Press **AC** to select AC coupling.
- Press **HF Reject** to select high frequency reject mode. High frequency rejection removes the high frequency portion of the triggering signal. This allows only the low frequency components to pass on to the triggering system. High frequency reject mode attenuates signals above 30 kHz.
- Press **LF Reject** to select low frequency reject mode. Low frequency rejection is the opposite of high frequency rejection. Low frequency reject mode attenuates signals below 80 kHz.

- Press **Noise Reject** to select noise reject mode. Noise rejection provides DC low sensitivity, but it requires additional signal amplitude for stable triggering.

Change Trigger Slope — Press the main menu button **Slope**. Use the top two side menu buttons to switch between positive-going and negative-going slope.

Adjust Trigger Level — Press the main menu button **Level**. Use the side menu to select from these options.

- Use the **General Purpose Knob** to adjust trigger level. (Note that this selection performs the same function as the trigger **LEVEL** knob on the front panel.)
- Press **Set to TTL** to automatically set the trigger level to the TTL switching threshold.
- Press **Set to ECL** to automatically set the trigger level to the ECL switching threshold.
- Press **Set to 50%** to set the trigger level to the midpoint of the trigger source signal. (Note that this selection performs the same function as the **SET LEVEL TO 50%** button on the front panel.)

Select Trigger Mode — Press the main menu button **Mode**. Use the side menu to select either **Auto** or **Normal** mode.

In normal trigger mode, the oscilloscope waits for a valid trigger from the trigger signal source. In auto trigger mode, the oscilloscope produces an internal trigger in the absence of other trigger events.

At horizontal scale settings of 100 ms per division and slower, auto trigger mode switches to an untriggered roll display. When the display is in “roll” mode the envelope and average acquisition modes does not work properly, and the display does not show a trigger “T” on the waveform.

Adjust Holdoff — Press the main menu button **Holdoff** to activate the **General Purpose Knob**. Use the knob to adjust holdoff; the TDS 300 Series have a holdoff range of 500 ns to 10 s. Press the side menu button **Set to Min** to quickly set the holdoff to 500 ns.

Video Triggering

The video trigger triggers on field 1, field 2, any field, or lines of an NTSC or PAL standard video signal. It can also trigger on nonstandard video signals with similar sync signals. You can access video trigger settings through the video trigger menu, shown in Figure 3-15.

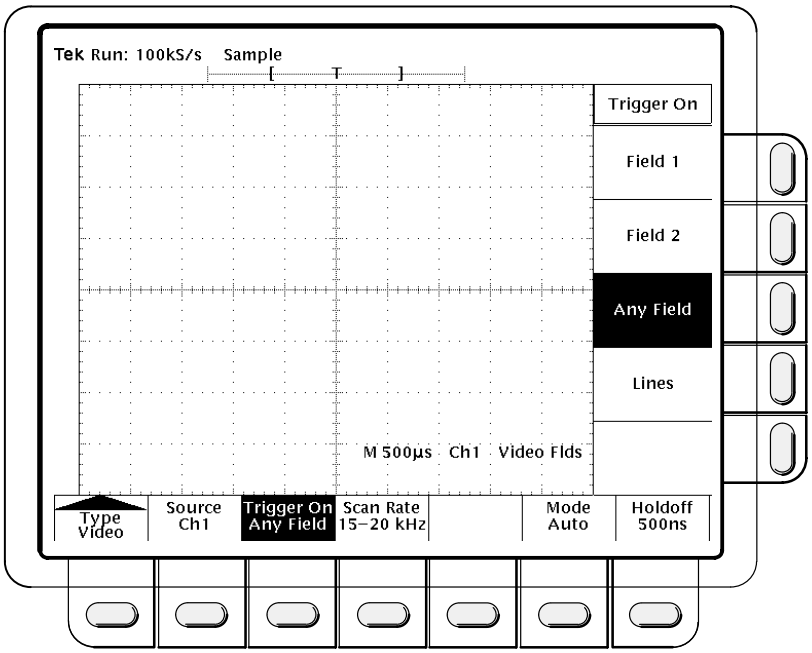


Figure 3-15: The Video Trigger Menu

Use the video trigger menu to perform these tasks.

Select Trigger Source, Mode, and Holdoff — These main menu selections perform exactly as in the edge trigger menu, because the two triggers share these parameters. For example, if you set the edge trigger holdoff to 2.3 ms and then switch to the video trigger, its holdoff will also be 2.3 ms.

Select Trigger Point — Press the main menu button **Trigger On** to select the part of the video signal on which the oscilloscope will trigger. Use the side menu to select from these options.

- Press **Field 1** to trigger on field 1 of the video signal.
- Press **Field 2** to trigger on field 2 of the video signal.
- Press **Any Field** to trigger on any field of the video signal.
- Press **Lines** to trigger on all lines of the video signal.

The video trigger can only trigger on negative-going sync. If you need to trigger on the positive-going sync of a signal, simply invert the signal from the vertical menu (see page 3-18).

Select Scan Rate — Press the main menu button **Scan Rate** to select the scan rate frequency range. Use the side menu to select from the following rates (see Figure 3-16):

- Press **Rate 1** to select a scan rate of 15 to 20 kHz.
- Press **Rate 2** to select a scan rate of 20 to 25 kHz.
- Press **Rate 3** to select a scan rate of 25 to 35 kHz.
- Press **Rate 4** to select a scan rate of 35 to 50 kHz.
- Press **Rate 5** to select a scan rate of 50 to 65 kHz.

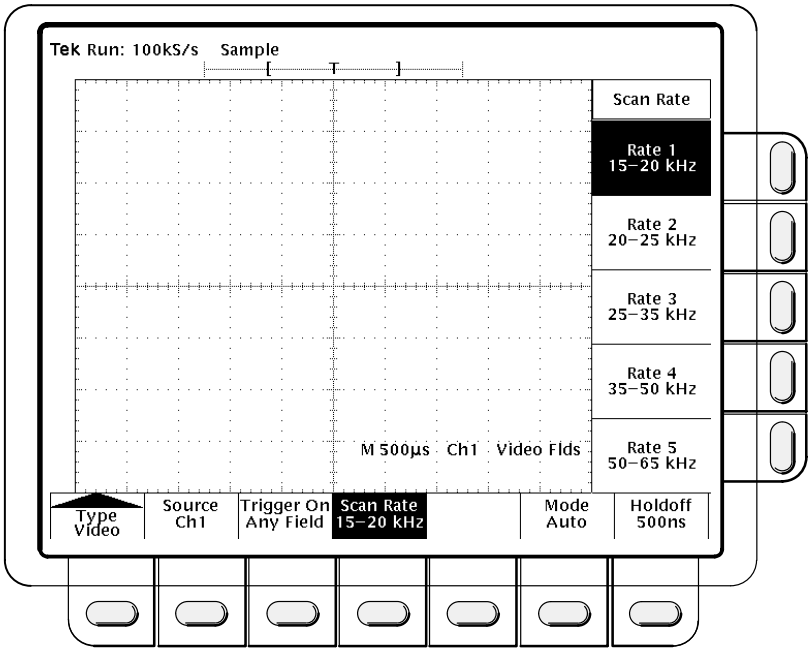


Figure 3-16: The Video Scan-Rate Menu

Taking Measurements

TDS 300 Series oscilloscopes have two features that make them easy for you to obtain quantitative data from a displayed waveform: automated measurements and cursors.

Automated Measurements

The oscilloscope can perform 21 different automated measurements on a waveform (four measurements at any one time). To access these measurements, press the **MEASURE** button, shown in Figure 3-17.

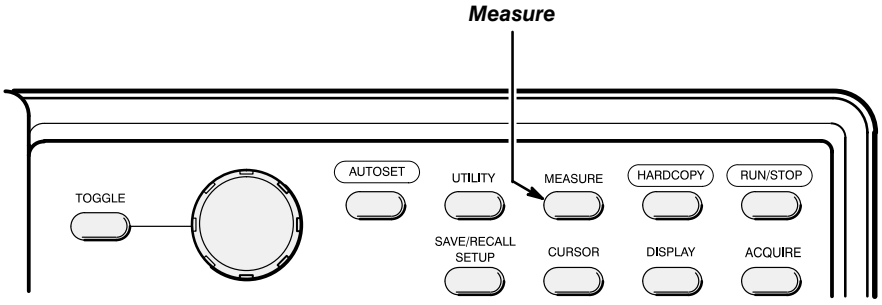


Figure 3-17: The MEASURE Button

The **MEASURE** button activates the measure menu, shown in Figure 3-18.

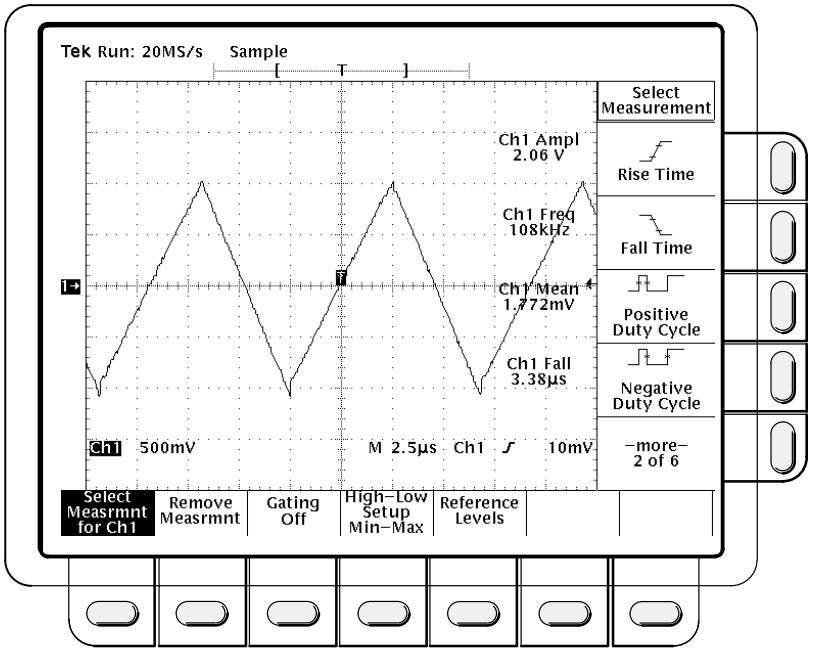


Figure 3-18: The Measure Menu and Active Measurements

Use the measure menu to perform the following tasks.

Activate a Measurement — Use this procedure to activate a measurement for the selected waveform.

1. Press the main menu button **Select Measrmnt for...**.
2. If necessary, press the lowermost side menu button (labeled **–more– x out of 6**) to page through the available measurements until the measurement you want to take appears in the side menu.
3. Then press one of the top four side menu buttons to activate a particular measurement.

The measured values appear to the left of the side menu, as shown in Figure 3-18. For definitions of the available measurements, see Table 3-1.

NOTE

*Measurements only remain active while the channel is active. If you activate several measurements for a channel and then press the **WAVEFORM OFF** button, the measurements disappear just like the waveform.*

Table 3-1: Measurement Definitions

Name	Definition
Period	Timing measurement. Time it takes for the first complete signal cycle to happen in the waveform or gated region. The reciprocal of frequency. Measured in seconds.
Frequency	Timing measurement for the first cycle in the waveform or gated region. The reciprocal of the period. Measured in Hertz (Hz) where 1 Hz = 1 cycle per second.
Positive Width	Timing measurement of the first pulse in the waveform or gated region. The distance (time) between MidRef (default 50%) amplitude points of a positive pulse.
Negative Width	Timing measurement of the first pulse in the waveform or gated region. The distance (time) between MidRef (default 50%) amplitude points of a negative pulse.
Rise time	Timing measurement. Time taken for the leading edge of the first pulse in the waveform or gated region to rise from a Low Ref value (default = 10%) to a High Ref value (default = 90%) of its final value.
Fall Time	Timing measurement. Time taken for the falling edge of the first pulse in the waveform or gated region to fall from a High Ref value (default = 90%) to a Low Ref value (default =10%) of its final value.
Positive Duty Cycle	Timing measurement of the first cycle in the waveform or gated region. The ratio of the positive pulse width to the signal period expressed as a percentage. $$PositiveDutyCycle = \frac{PositiveWidth}{Period} \times 100\%$$
Negative Duty Cycle	Timing measurement of the first cycle in the waveform or gated region. The ratio of the negative pulse width to the signal period expressed as a percentage. $$NegativeDutyCycle = \frac{NegativeWidth}{Period} \times 100\%$$
Burst Width	Timing measurement. The duration of a burst. Measured over the entire waveform or gated region.
Positive Overshoot	Voltage measurement over the entire waveform or gated region. $$PositiveOvershoot = \frac{Max - High}{Amplitude} \times 100\%$$
Negative Overshoot	Voltage measurement. Measured over the entire waveform or gated region. $$NegativeOvershoot = \frac{Low - Min}{Amplitude} \times 100\%$$
High	The value used as 100% whenever High Ref, Mid Ref, and Low Ref values are needed (as in fall time and rise time measurements). Measured over the entire waveform or gated region.

Table 3-1: Measurement Definitions (Cont.)

Name	Definition
 **Low**	The value used as 0% whenever High Ref, Mid Ref, and Low Ref values are needed as in fall time and rise time measurements. Measured over the entire waveform or gated region.
 **Maximum**	Voltage measurement. The maximum amplitude. Typically the most positive peak voltage. Measured over the entire waveform or gated region.
 **Minimum**	Voltage measurement. The minimum amplitude. Typically the most negative peak voltage. Measured over the entire waveform or gated region.
 **Peak to Peak**	Voltage measurement. The absolute difference between the maximum and minimum amplitude in the entire waveform or gated region.
 **Amplitude**	Voltage measurement. The high value less the low value measured over the entire waveform or gated region. *Amplitude = High − Low*
 **Mean**	Voltage measurement. The arithmetic mean over the entire waveform or gated region.
 **Cycle Mean**	Voltage measurement. The arithmetic mean over the first cycle in the waveform, or the first cycle in the gated region.
 **Cycle RMS**	Voltage measurement. The true Root Mean Square voltage over the first cycle in the waveform, or the first cycle in the gated region.
 **RMS**	Voltage measurement. The true Root Mean Square voltage over the entire waveform or gated region.

Remove a Measurement — Press the main menu button **Remove Measrmnt**. Use the top four side menu buttons to remove specific measurements or use the lowest side menu button to remove all measurements.

Use Gating — By default, TDS 300 Series oscilloscopes take automated measurements on the entire waveform record. If you want a measurement of only a portion of the waveform, you can use gating to mark the boundaries of that portion. Use this procedure to "gate" a signal.

1. Press the main menu button **Select Measrmnt for...**.
2. If necessary, press the lowermost side menu button (labeled **−more− x out of 6**) to page through the available measurements until the measurement you want to take appears in the side menu.
3. Then press one of the top four side menu buttons to activate a particular measurement.
4. Press the main menu button **Gating**.
5. Press the side menu button **Gate with V Bar Cursors**.
6. Use the **General Purpose Knob** to set one cursor to the left edge of your gate.

7. Press **TOGGLE**.
8. Use the **General Purpose Knob** to set the other cursor to the right edge of the gate. All automated measurements now take data only from the portion of the waveform that is within the gate.
9. Press **Gate Off** to turn gating off.

NOTE

Gate Off *deactivates the gating function, but it does not deactivate the vertical cursors. Deactivate the cursors from the cursor menu as described in the next section.*

Switch High-Low Setup — Press the main menu button **High–Low Setup** to change the way the measurement system determines the high and low levels of waveforms. Use the side menu to select from these options.

- Press **Histogram** to set the levels statistically. The oscilloscope attempts to find the highest density of points above and below the midpoint, ignoring spikes. This method works well for measuring square waves and pulse waveforms.
- Press **Min–Max** to set the levels to the lowest amplitude (most negative) and highest amplitude (most positive) samples.

Set Reference Levels — Press the main menu button **Reference Levels** to set the high, middle, and low reference levels. The oscilloscope uses these levels for rise time, fall time, width, and overshoot measurements. Use the side menu to select from these options.

- Press **Set Levels in** to toggle the units of the reference levels. Switch between volts and percent.
- Press **High Ref**, **Mid Ref**, or **Low Ref** to select a particular reference level. Use the **General Purpose Knob** to alter the selected reference level. The defaults are 90%, 50%, and 10%, respectively.

Taking Measurements with Cursors

You can also take quantitative measurements of a waveform with the cursor system. To take measurements with cursors, follow this procedure.

1. Press the front panel button **CURSOR**, shown in Figure 3-19. The **CURSOR** button calls up the cursor menu, shown in Figure 3-20.

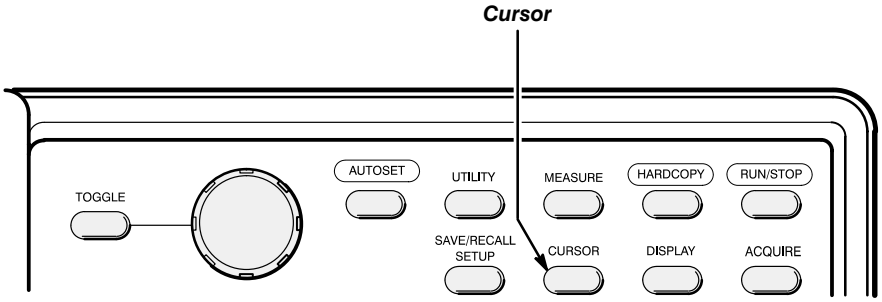


Figure 3-19: The CURSOR Button

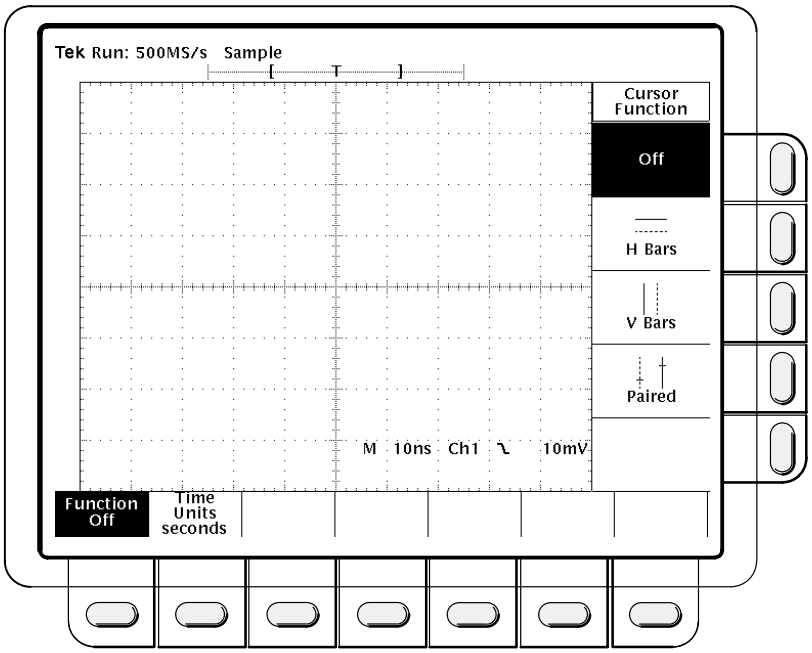


Figure 3-20: The Cursor Menu

2. If you want to take a time measurement in Hertz instead of seconds, press the main menu button **Time Units** and use the side menu to switch between the two.
3. If the main menu selection **Function** is not highlighted, press its main menu button.
4. Use the side menu to select the type of measurement you want to take. Select **H Bars** to take a voltage measurement, select **V Bars** to take a time measurement, or select **Paired** to take simultaneous voltage and time measurements.

5. Use the **General Purpose Knob** to move one cursor to a desired measurement point. For example, if you wanted to measure both the peak-to-peak voltage and period of a sine wave, you would start by moving one paired cursor to a “trough” (see Figure 3-21).

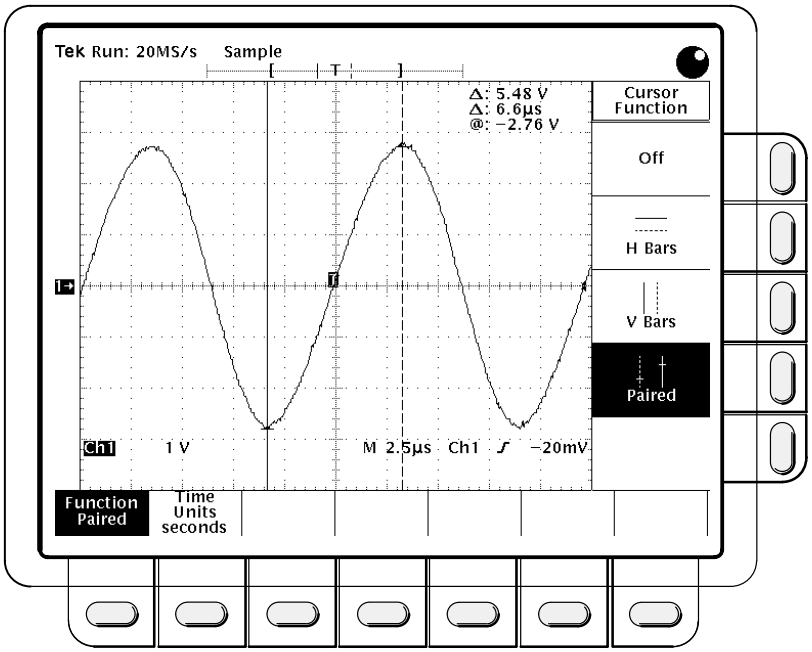


Figure 3-21: Paired Cursor Measurements of a Sine Wave

6. Press **TOGGLE**.
7. Use the **General Purpose Knob** to move the second cursor to another desired measurement point. To continue the example, you would move the second cursor to the previous “peak.”
8. Read the measured value(s) at the upper right corner of the display next to the Δ sign(s). Figure 3-21 shows a sine wave with a 5.48 V_{p-p} and a 13.2 µs period (6.6 µs X 2).

Controlling Acquisition

To access the acquisition controls, press the front panel button **ACQUIRE**, shown in Figure 3-22.

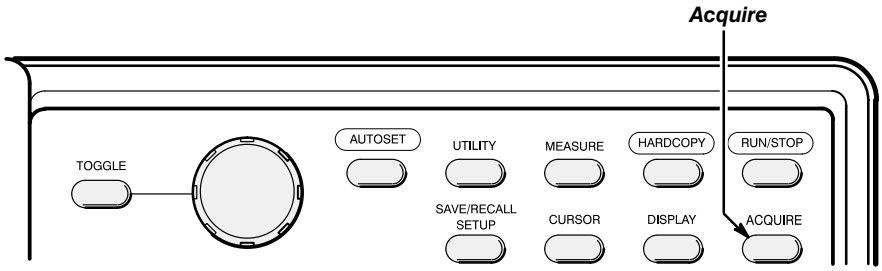


Figure 3-22: The ACQUIRE Button

The **ACQUIRE** button activates the acquire menu, shown in Figure 3-23.

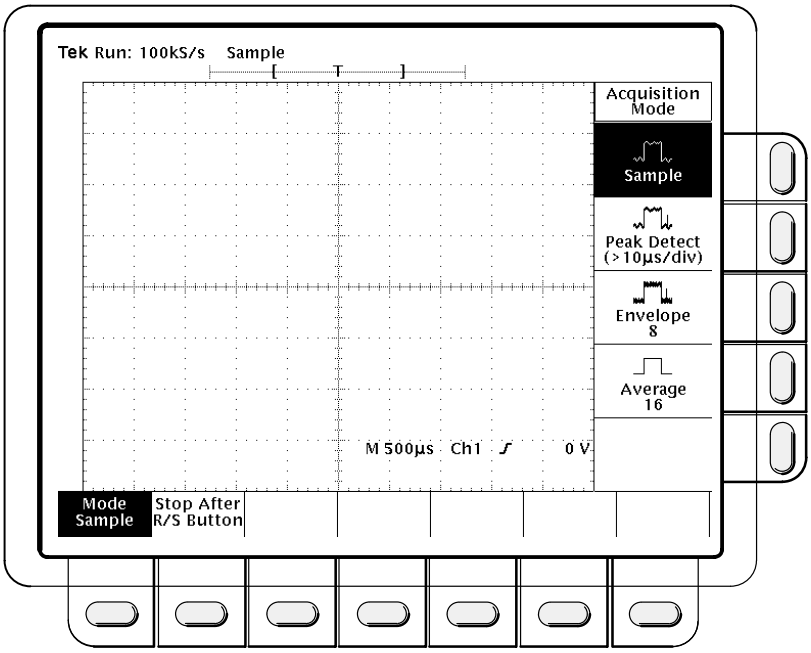


Figure 3-23: The Acquire Menu

Use the acquire menu to perform these tasks.

Select Acquisition Mode — Press the main menu button **Mode**. Use the side menu to select from these modes.

- Press **Sample** to select sample mode.
- Press **Peak Detect** to select peak detect mode. Peak detect mode only operates at **SEC**/**DIV** settings of 25 µs or slower.
- Press **Envelope** to select envelope mode. Use the **General Purpose Knob** to adjust the number of envelopes (2, 4, 8, 16, 32, 64, 128, 256, or ∞).
- Press **Average** to select average mode. Use the **General Purpose Knob** to adjust the number of acquisitions to average (2, 4, 8, 16, 32, 64, 128, or 256).

Activate Single Sequence Mode — Press the main menu button **Stop After** and then the side menu button **Single Acquisition Sequence**.

When in single sequence mode, the oscilloscope acquires a single sequence, display it, and then waits for you to press the **RUN**/**STOP** button.

The exact nature of a “sequence” depends on the present acquisition mode. In sample or peak detect mode, a “sequence” is a single acquisition. In envelope or average mode, a “sequence” is a number of acquisitions equal to the number of envelopes or averages.

For example, when both average and single sequence mode are active and the number of averages is 16, the oscilloscope collects 16 acquisitions, averages them, displays the resulting waveform, and stops until you press the **RUN**/**STOP** button.

To deactivate single sequence mode, press the side menu button **RUN**/**STOP button only**.

Controlling the Display

To access the display controls, press the front panel button **DISPLAY**, shown in Figure 3-24.

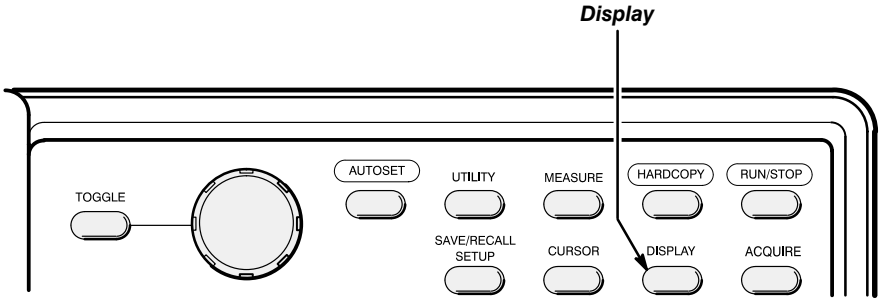


Figure 3-24: The DISPLAY Button

The **DISPLAY** button activates the display menu, shown in Figure 3-25.

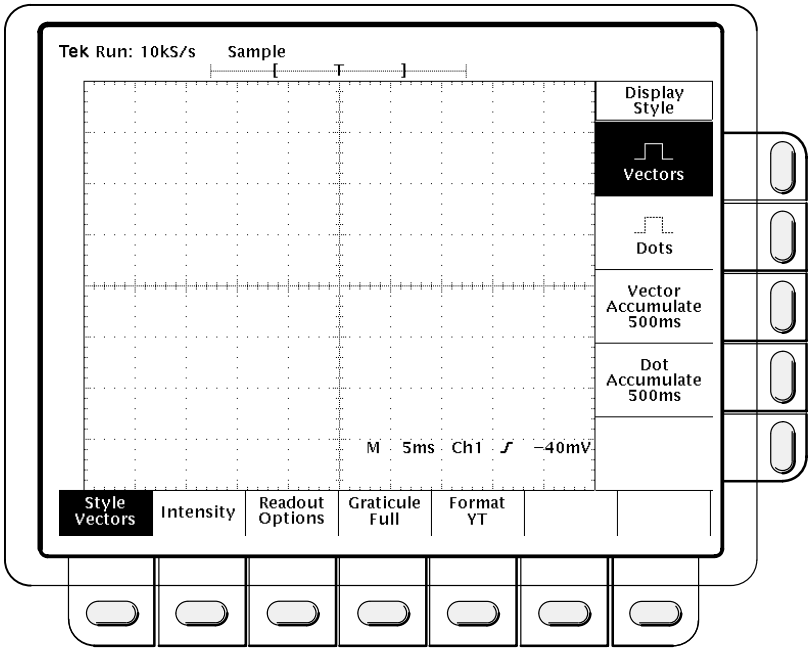


Figure 3-25: The Display Menu

Use the display menu to perform these tasks.

Select Display Style — Press the main menu button **Style**. Use the side menu to select from these display styles.

- Press **Vectors** to select vector display style. The oscilloscope draws a vector between each pair of waveform points.
- Press **Dots** to select dot display mode. The oscilloscope displays only the waveform points.
- Press **Vector Accumulate** or **Dot Accumulate** to set the display to accumulate dots. Use the **General Purpose Knob** to adjust the time limit (from 500 ms to 10 s in 250 ms increments or ∞). The display accumulates dots until it reaches the time limit. It then clears the waveform and starts over. **Dot Accumulate** mode shows the latest acquired waveform in dot format, while **Vector Accumulate** mode shows it in vector format.

Adjust Display Intensity — Press the main menu button **Intensity**. Use the side menu to select from the following.

- Press **Overall** to adjust the intensity of the screen as a whole. Use the **General Purpose Knob** to vary screen intensity.
- Toggle **Text**/**Grat** to switch the text and graticule between bright and dim.
- Toggle **Waveform** to switch the waveform between bright and dim.
- Press **Contrast** to adjust the contrast between the bright and dim settings. Use the **General Purpose Knob** to vary the contrast level from 100% to 250%. (When you set contrast to 200%, the dim setting is half as bright as the bright setting.)

Add or Remove the Trigger 'T' — By default, TDS 300 oscilloscopes display a 'T' at the trigger point. Press the main menu button **Readout Options** and then toggle the **Display 'T' @ Trigger Point** button to remove and add this feature.

Select Between Full and Frame Graticule — Press the main menu button **Graticule** and then use the side menu to switch between a full graticule and a simple frame.

Select Display Format — Press the main menu button **Format** and then use the side menu to switch between YT and XY modes.

Making Hardcopies (Option 14 Equipped Instruments Only)

By using the Option 14 Communications Interface, you can make hardcopies of waveforms with the oscilloscope. To make a hardcopy, connect your hardcopy device to the appropriate interface on the rear panel and press the **HARDCOPY** button, shown in Figure 3-26.

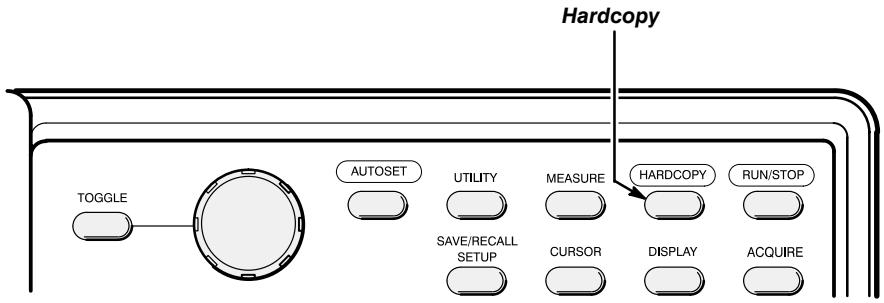


Figure 3-26: The HARDCOPY Button

To abort a hard copy enter the **System I/O** menu as described in the next section and press the main menu button **Clear Spool**.

Configuring Hard Copy Output

Before you can successfully make a hard copy, you need to configure the hard copy output to match your hard copy device. Use this procedure.

1. Press the **UTILITY** button, shown in Figure 3-27.

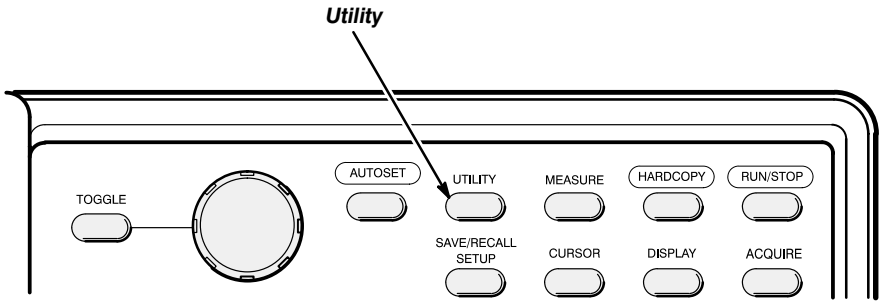


Figure 3-27: The UTILITY Button

2. Repeatedly press the leftmost main menu button until **I/O** is highlighted in the pop-up. This activates the system I/O menu, shown in Figure 3-28.

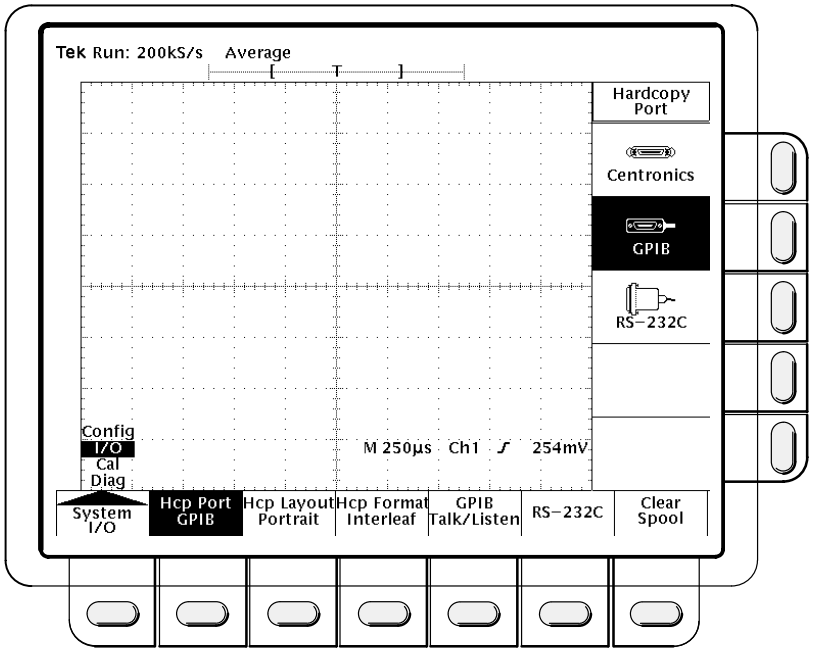


Figure 3-28: The System I/O Menu

3. Press the main menu button **Hcp Port**. Use the side menu to select **Centronics**, **GPIB**, or **RS-232C**.
4. Press the main menu button **Hcp Layout**. Use the side menu to select **Landscape** or **Portrait**.
5. Press the main menu button **Hcp Format**. Use the side menu to select your printer format (press the lowermost side menu button, labeled **−more− x of 3**, to page through the formats as necessary). Formats available are **Thinkjet**, **Deskjet**, **Laserjet**, **Epson**, **Interleaf**, **TIFF**, **PCX**, **BMP**, **EPS** (Encapsulated PostScript), **DPU 411/II**, and **DPU 412**.
6. If you are using the GPIB as your hard copy port, press the main menu button **GPIB**. Then press the side menu button **Hardcopy (Talk Only)**.
7. If you are using the RS-232C as your hard copy port, press the main menu button **RS-232C**. Then press, in turn, each side menu button until the desired parameter settings are displayed in the side menu. Or, if its settings are appropriate, press **Set RS-232 Parameters to Default Values**. Remember, the parameter settings you select must be compatible with the settings of your hardcopy device or personal computer. (For additional RS-232 information see your *TDS 310, TDS 320, & TDS 350 Programmer Manual*.)

You are now ready to make a hard copy.

Saving and Recalling Front-Panel Setups

TDS 300 Series oscilloscopes can store up to ten front-panel setups in internal memory for an indefinite period. To access front-panel save and recall features, press the **SAVE/RECALL SETUP** button, shown in Figure 3-29.

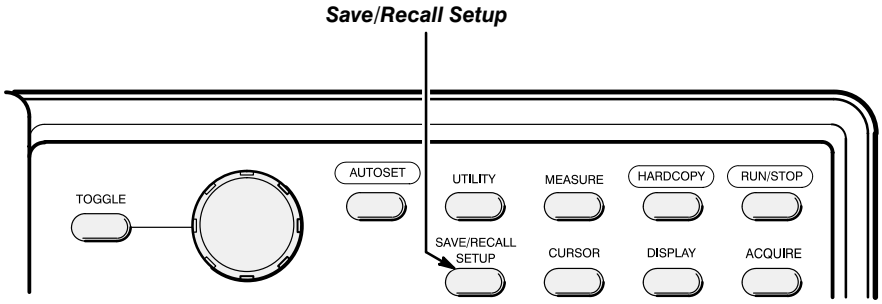


Figure 3-29: The SAVE/RECALL SETUP Button

Pressing the button activates the save/recall setup menu, shown in Figure 3-30.

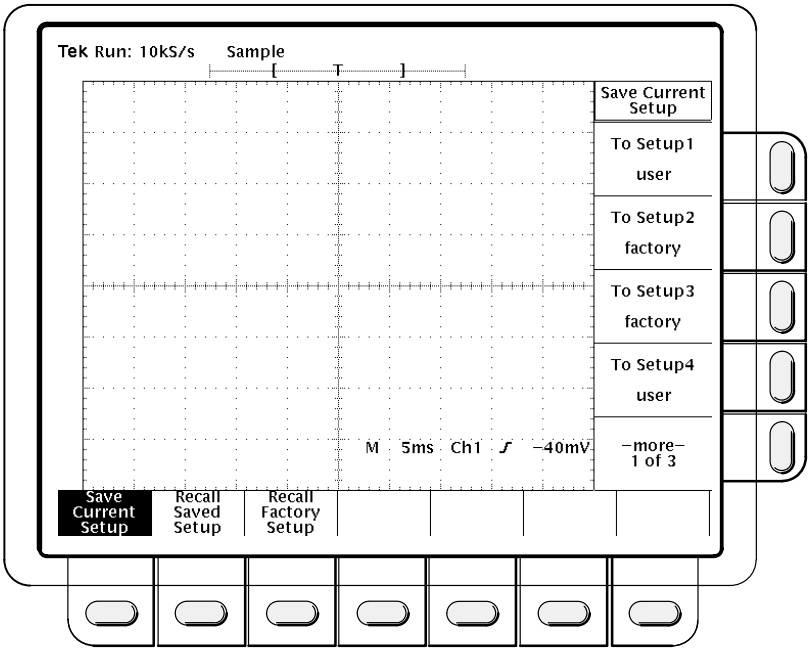


Figure 3-30: The Save/Recall Setup Menu

Use the save/recall setup menu to perform the following tasks.

Save the Current Setup — Press the main menu button **Save Current Setup**. Then select a setup from the side menu (press the lowermost side menu button, labeled **−more− x of 3**, to page through the setups). Then press the side menu button **OK Overwrite Saved Setup**.

Recall a Saved Setup — Press the main menu button **Recall Saved Setup**. Then select a destination setup memory from the side menu (press the lowermost side menu button, labeled **−more− x of 3**, to page through the setups).

Recall the Factory Setup — Press the main menu button **Recall Factory Setup**. Then press the side menu button **OK Confirm Factory Init**.

NOTE

The Tek Secure feature (page 3-47) will erase all saved setups.

Using the Utility Menu

The utility menu is actually four menus in one. Access these menus by pressing the **UTILITY** button (Figure 3-31) and then the leftmost main menu button. The pop-up menu (see Figure 3-32) shows these options.

- The **Config** menu offers Tek Secure (which overwrites all setup and reference memories) and the software version identifier as main menu selections.
- The **I/O** menu (Option 14 instruments only) pertains to making hardcopies (see page 3-43) and remote operations (see the *TDS 310, TDS 320, & TDS 350 Programmer Manual*).
- The **Cal** menu, which you should only use in conjunction with the adjustment procedures (page 7-1).
- The **Diag** menu, which you should only use in conjunction with the troubleshooting procedures (page 8-27).

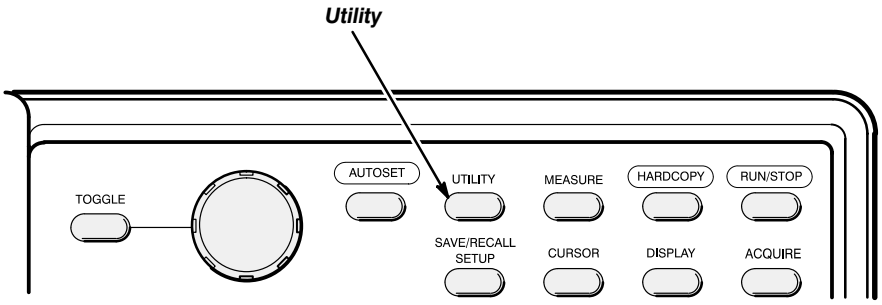


Figure 3-31: The Utility Button

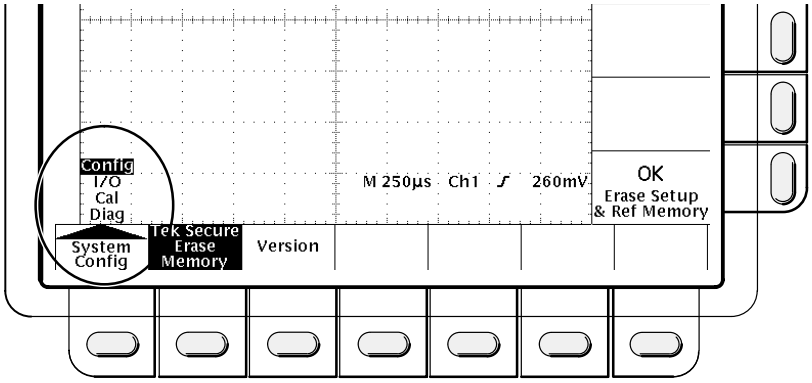


Figure 3-32: The Utility Pop-Up Menu

Specifications

Specifications

This section contains complete specifications for the TDS 310, TDS 320, and TDS 350. The specifications are divided into three subsections, one for each of three classes of traits: *warranted characteristics, typical characteristics,* and *nominal traits*.

Warranted Characteristics

Warranted characteristics are described in terms of quantifiable performance limits that are warranted. This subsection lists only warranted characteristics.

NOTE

In these tables, those warranted characteristics that are checked in the Performance Tests*, starting on page 6-11, appear in* ***boldface type*** *under the column* **Name**.

Performance Conditions

The electrical characteristics found in these tables of warranted characteristics apply when the oscilloscope has been adjusted at an ambient temperature between +20° C and +30° C, has had a warm-up period of at least 20 minutes, and is operating at an ambient temperature between −10° C and +55° C (unless otherwise noted).

Table 4-1: Warranted Characteristics — Signal Acquisition System

Name	Description	
Accuracy, DC Voltage Measurement, Average Acquisition Mode	**Measurement Type**	**DC Accuracy**
	Average of ≥16 waveforms	±(2.0% × \|(reading − Net Offset)\| + Offset Accuracy + 0.1 div)
	Delta volts between any two averages of ≥16 waveforms acquired under the same setup and ambient conditions	±(2.0% × \|reading\| + 0.15 div + 0.3 mV)
Accuracy, DC Gain, Sample or Average Acquisition Modes	±2%	
Pulse Response, Peak Detect and Envelope Mode	**Sec/Div Setting**	**Minimum Pulse Width**
	5 s/div − 25 µs/div	10 ns
	TDS 310: 10 µs/div − 10 ns/div TDS 320: 10 µs/div − 5 ns/div TDS 350: 10 µs/div − 2.5 ns/div	The greater of 10 ns or .02 × sec/div setting

Table 4-1: Warranted Characteristics — Signal Acquisition System (Cont.)

Name	Description	
Accuracy, Offset	**Volts/Div Setting**	**Offset Accuracy**
	2 mV/div – 99.5 mV/div	±(0.4% × \|Net Offset[1]\| + 3 mV + 0.1 div × V/div setting)
	100 mV/div – 995 mV/div	±(0.4% × \|Net Offset[1]\| + 30 mV + 0.1 div × V/div setting)
	1 V/div – 10 V/div	±(0.4% × \|Net Offset[1]\| + 300 mV + 0.1 div × V/div setting)
Analog Bandwidth, DC Coupled	TDS 310: DC – ≥50 MHz TDS 320: DC – ≥100 MHz TDS 350: DC – ≥200 MHz; DC – ≥180 MHz for 2 mV/div	
Cross Talk (Channel Isolation)	≥100:1 at 50 MHz with equal Volts/Div settings on each channel	
Input Impedance, DC-Coupled	1 MΩ ±1% in parallel with 20 pF ±2.0 pF	
Input Voltage, Maximum	±400 V (DC + peak AC); derate at 20 dB/decade above 100 kHz to 13 V peak AC at 3 MHz and above	
Lower Frequency Limit, AC Coupled[2]	≤10 Hz	

[1]Net Offset = Offset – (Position × Volts/Div). Net offset is the voltage level at the center of the A-D converter dynamic range. Offset Accuracy is the accuracy of this voltage level.

[2]The AC Coupled Lower Frequency Limits are reduced by a factor of 10 when 10X, passive probes are used.

Table 4-2: Warranted Characteristics — Time Base System

Name	Description
Accuracy, Long Term Sample Rate and Delay Time	±100 ppm over any ≥1 ms interval
Accuracy, Delta Time Measurements[1, 2]	For single-shot acquisitions using sample acquisition mode and a bandwidth limit setting of FULL: ±(1 WI + 100 ppm × \|Reading\| + 0.6 ns) For repetitive acquisitions using average acquisition mode with ≥16 averages and a bandwidth limit setting of FULL: ±(1 WI + 100 ppm × \|Reading\| + 0.4 ns)

[1]For input signals ≥5 divisions in amplitude and a slew rate of ≥2.0 divisions/ns at the delta time measurement points. Signal must be acquired at a volts/division setting ≥5 mV/division.

[2]The WI (waveform interval) is the time between the samples in the waveform record. Also, see the footnotes for *Sample Rate Range* and *Equivalent Time or Interpolated Waveform Rates* in Table 4-11 on page 4-12.

Table 4-3: Warranted Characteristics — Triggering System

Name	Description	
Accuracy, Trigger Level, DC Coupled	**Trigger Source**	**Sensitivity**
	CH1 or CH2	±(3% of \|Setting − Net Offset[1]\| + 0.2 div × volts/div setting + Offset Accuracy)
	External	±(6% of \|Setting\| + 20 mV)
	External/10	±(6% of \|Setting\| 200 mV)
Sensitivity, Edge-Type Trigger, DC Coupled	**Trigger Source**	**Sensitivity**
	CH1 or CH2	TDS 310: 0.35 division from DC to 20 MHz, increasing to 1 div at 50 MHz
		TDS 320: 0.35 division from DC to 50 MHz, increasing to 1 div at 100 MHz
		TDS 350: 0.35 division from DC to 50 MHz, increasing to 1 div at 200 MHz
	External	TDS 310: 50 mV from DC to 20 MHz, increasing to 150 mV at 50 MHz
		TDS 320: 50 mV from DC to 50 MHz, increasing to 150 mV at 100 MHz
		TDS 350: 50 mV from DC to 50 MHz, increasing to 150 mV at 200 MHz
	External/10	TDS 310: 500 mV from DC to 20 MHz, increasing to 1.5 V at 50 MHz
		TDS 320: 500 mV from DC to 50 MHz, increasing to 1.5 V at 100 MHz
		TDS 350: 500 mV from DC to 50 MHz, increasing to 1.5 V at 200 MHz
Input Impedance, External Trigger	1 MΩ ±2% in parallel with 20 pF ±2 pF	
Maximum Input Voltage, External Trigger	±400 V (DC + peak AC); derate at 20 dB/decade above 100 kHz to 13 V peak AC at 3 MHz and above	

[1]Net Offset = Offset − (Position × Volts/Div). Net Offset is the voltage level at the center of the A-D converter dynamic range. Offset Accuracy is the accuracy of this voltage level.

Table 4-4: Power Requirements

Name	Description
Source Voltage and Frequency	90 to 132 VAC_{RMS}, continuous range, for 47 Hz through 440 Hz 132 to 250 VAC_{RMS}, continuous range, for 47 Hz through 63 Hz
Power Consumption	≤65 Watts (120 VA)

Table 4-5: Warranted Characteristics — Environmental, Safety, and Reliability

Name	Description
Atmospherics	Temperature: −10° C to +55° C, operating; −51° C to +71° C, non-operating Relative humidity: to 95%, at or below +40° C; to 75%, +41° C to +55° C Altitude: To 15,000 ft (4570 m), operating; to 40,000 ft (12190 m), non-operating
Dynamics	Random vibration: 0.31 g_{RMS}, from 5 to 500 Hz, 10 minutes each axis, operating; 2.46 g_{RMS}, from 5 to 500 Hz, 10 minutes each axis, non-operating
Emissions[1]	Meets or exceeds the requirements of the following standards: EN 50081−1 European Community Requirements EN 55022 radiated emissions EN 55022 Class B conducted emissions EN 60555−2 power harmonics VFG 0243 FCC Rules and Regulations, 47 CFR, Part 15, Subpart B, Class A
Susceptibility[2]	TDS 310 and TDS 320: ≤±0.2 division waveform displacement, or ≤0.4 division increase in p-p noise. TDS 350: ≤±0.2 division waveform displacement, or ≤0.4 division increase in p-p noise below 200 MHz. ≤±0.3 division waveform displacement, or ≤±0.6 division increase in p-p noise from 200 MHz to 500 MHz. The instruments are subjected to the EMI specified in the following standards: EN 50082−1 European Community Requirements IEC 801−3 radiated susceptibility IEC 801−4 fast transients IEC 801−5 AC surge

[1]To maintain emission requirements when connecting to the I/O interface of this oscilloscope, use only a high-quality, double-shielded (braid and foil) cable. The cable shield must have low impedance connections to both connector housings. The VGA cable must also have ferrite cores at either end. Acceptable cables are listed in Table 1-6 on page 1-6.

[2]Susceptibility test run with both channel inputs terminated with grounding caps, both channels set to 2 mV/Div, DC Coupling, the trigger source set to Line, the Acquisition Mode set to Peak Detect, and the time base set to 25 µs/Div.

Typical Characteristics

Typical characteristics are described in terms of typical or average performance. Typical characteristics are not warranted.

Table 4-6: Typical Characteristics — Signal Acquisition System

Name	Description			
Accuracy, DC Gain, Envelope Acquisition Mode	±3% for sec/div settings from 5 Sec/Div to 25 µsec/div; ±2% for sec/div settings from 10 µs/div to 10 ns/div (TDS 310); ±2% for sec/div settings from 10 µs/div to 5 ns/div (TDS 320); ±2% for sec/div settings from 10 µs/div to 2.5 ns/div (TDS 350)			
Accuracy, DC Voltage Measurement, Sample Acquisition Mode	**Measurement Type**		**DC Accuracy**	
	Any Sample		±(2.0% × (\|reading − Net Offset[1]\|) + Offset Accuracy + 0.13 div + 0.6 mV)	
	Delta Volts between any two samples[2] acquired under the same set-up and ambient conditions		±(2.0% × \|reading\| + 0.26 div + 1.2 mV)	
Frequency Limit, Upper, 20 MHz Bandwidth Limited	20 MHz			
Step Response Settling Error	**Volts/Div Setting**	**Step Amplitude**	**Settling Error (%)[3]**	
			100 ns	**20 ms**
	2 mV/div − 99.5 mV/div	≤2 V	≤1.0	≤0.1
	100 mV/div − 995 mV/div	≤20 V	≤1.5	≤0.2
	1 V/div − 10 V/div	≤200 V	≤2.5	≤0.2
Common Mode Rejection Ratio (CMRR)	100:1 at 60 Hz, reducing to 20:1 at 50 MHz, with equal Volts/Div and Coupling settings on each channel.			

[1]Net Offset = Offset − (Position × Volts/Div). Net Offset is the voltage level at the center of the A-D converter dynamic range. Offset Accuracy is the accuracy of this voltage level.

[2]The samples must be acquired under the same setup and ambient conditions.

[3]The values given are the maximum absolute difference between the value at the end of a specified time interval after the mid-level crossing of the step, and the value one second after the mid-level crossing of the step, expressed as a percentage of the step amplitude.

[4]Reference is a 9-div p-p sine wave input sampled at 200 MS/s for the TDS 310, 500 MS/s for the TDS 320, and 1 GS/s for the TDS 350.

Table 4-7: Typical Characteristics — Triggering System

Name	Description	
Error, Trigger Position, Edge Triggering	**Acquire Mode**	**Trigger-Position Error[1,2]**
	Sample, Average	±(1 WI + 2 ns)
	Peak Detect, Envelope	±(2 WI + 2 ns)
Sensitivity, Video-Type Trigger	**Source**	**Typical Sensitivity**
	CH1 or CH2 External External/10	0.6 division of video sync signal 75 mV of video sync signal 750 mV of video sync signal
Lowest Frequency for Successful Operation of "Set Level to 50%" Function	50 Hz	
Sensitivity, Edge Type Trigger, Not DC Coupled[3]	**Trigger Coupling**	**Typical Signal Level for Stable Triggering**
	AC	Same as DC-coupled limits[4] for frequencies above 60 Hz. Attenuates signals below 60 Hz.
	Noise Reject	Three and one half times the DC-coupled limits.[4]
	High Frequency Reject	One and one half times times the DC-coupled limits[4] from DC to 30 kHz. Attenuates signals above 30 kHz.
	Low Frequency Reject	One and one half times the DC-coupled limits[4] for frequencies above 80 kHz. Attenuates signals below 80 kHz.

[1]The trigger position errors are typically less than the values given here. These values are for triggering signals having a slew rate at the trigger point of ±0.5 division/ns.

[2]The waveform interval (WI) is the time between the samples in the waveform record. Also, see the footnote for the characteristics *Sample Rate Range* and *Equivalent Time or Interpolated Waveform Rates* in Table 4-11 on page 4-12.

[3]The minimum sensitivity for obtaining a stable trigger. A stable trigger results in a uniform, regular display triggered on the selected slope. The trigger point must not switch between opposite slopes on the waveform, and the display must not "roll" across the screen on successive acquisitions. The TRIG'D LED stays constantly lighted when the SEC/DIV setting is 2 ms or faster but may flash when the SEC/DIV setting is 10 ms or slower.

[4]See the characteristic *Sensitivity, Edge-Type Trigger, DC Coupled* in Table 4-3, which begins on page 4-5.

Table 4-8: Typical Characteristics — Probe Compensator Output

Name	Description	
Output Voltage and Frequency, Probe Compensator	**Characteristic**	
	Voltage	5.0 V (low-high) into a 1 MΩ load
	Frequency	1 kHz

Table 4-9: Typical Characteristics — Data Handling

Name	Description
Time, Data-Retention, Nonvolatile Memory[1,2]	≥5 Years

[1]The time that reference waveforms, stored setups, and calibration constants are retained when there is no power to the oscilloscope.

[2]Data is maintained by a lithium poly-carbon monofluoride battery.

Nominal Traits

Nominal traits are described using simple statements of fact such as “Two, identical” for the trait “Input Channels, Number of,” rather than in terms of limits that are performance requirements.

Table 4-10: Nominal Traits — Signal Acquisition System

Name	Description	
Bandwidth Selections	20 MHz and FULL	
Digitizers, Number of	Two, identical, digitized simultaneously	
Digitized Bits, Number of	8 bits[1]	
Input Channels, Number of	Two, identical, called CH 1 and CH 2	
Input Coupling	DC, AC, or GND	
Ranges, Offset, All Channels	**Volts/Div Setting**	**Offset Range**
	2 mV/div – 99.5 mV/div	±1 V
	100 mV/div – 995 mV/div	±10 V
	1 V/div – 10 V/div	±100 V
Range, Position	±5 divisions	
Range, Sensitivity[2]	2 mV/div to 10 V/div	
Rise Time	TDS 310: 7 ns TDS 320: 3.5 ns TDS 350: 1.75 ns	
TekProbe Interface	Level one probe coding	

[1]Displayed vertically with 25 digitization levels (DLs) per division and 10.24 divisions dynamic range with zoom off. A DL is the smallest voltage level change that the 8-bit A-D Converter can resolve, with the input scaled to the volts/division setting of the channel used. Expressed as a voltage, a DL is equal to 1/25 of a division times the volts/division setting.

[2]The sensitivity ranges from 2 mV/div to 10 V/div in a 1–2–5 sequence of coarse settings. Between consecutive coarse settings, the sensitivity can be finely adjusted with a resolution of 1% of the more sensitive setting. For example, between 50 mV/div and 100 mV/div, the volts/division can be set with 0.5 mV resolution.

Table 4-11: Nominal Traits — Time Base System

Name	Description
Range, Sample-Rate[1,2]	TDS 310: 10 Samples/s to 200 MSamples/s in a 1−2−5 sequence TDS 320: 10 Samples/s to 500 MSamples/s in a 1−2−5 sequence TDS 350: 10 Samples/s to 1 GSamples/s in a 1−2−5 sequence
Range, Seconds/Division	TDS 310: 10 ns/div to 5 s/div in a 1−2.5−5 sequence TDS 320: 5 ns/div to 5 s/div in a 1−2.5−5 sequence TDS 350: 2.5 ns/div to 5 s/div in a 1−2.5−5 sequence
Range, Time Base Delay Time	16.5 ns to 50 seconds
Record Length	1,000 samples

[1]The range of real-time rates, expressed in samples/second, at which a digitizer samples signals at its inputs and stores the samples in memory to produce a record of time-sequential samples

[2]The Waveform Rate (WR) is the equivalent sample rate of a waveform record. For a waveform record acquired by real-time sampling of a single acquisition, the waveform rate is the same as the real-time sample rate; for a waveform created by interpolation of real-time samples from a single acquisition or by equivalent-time sampling of multiple acquisitions, the waveform rate is faster than the real time sample rate. For all three cases, the waveform rate is 1/(Waveform Interval) for the waveform record, where the waveform interval (WI) is the time between the samples in the waveform record.

Table 4-12: Nominal Traits — Triggering System

Name	Description	
Range, Hold Off	500 ns minimum to 10 seconds maximum	
Ranges, Trigger Level	**Source**	**Range**
	Any Channel	±12 divisions from center of screen
	External	±1.5 Volts
	External /10	±15 Volts
	Line	±300 Volts
Formats and Field Rates, Video Trigger	Triggers from sync-negative composite video, 525 to 625 lines, 50 Hz to 60 Hz, interlaced or noninterlaced systems with scan rates from 15 kHz to 65 kHz − such as NTSC, PAL, or SECAM	
TekProbe Interface, External Trigger	Level one probe coding	

Table 4-13: Nominal Traits — Display System

Name	Description
CRT Type	7-inch (17.95 cm) diagonal, magnetic deflection; horizontal raster-scan; P31 green phosphor
Video Display Resolution	640 pixels horizontally by 480 pixels vertically Display area is 5.04 inch (12.92 cm) horizontally by 3.78 inch (9.69 cm) vertically

Table 4-13: Nominal Traits — Display System (Cont.)

Name	Description
Waveform Display Graticule	A single graticule 401 × 501 pixels (8 × 10 divisions, with divisions that are approximately 1 cm by 1 cm)
Intensity Levels	Dim and Bright, with adjustable Overall Intensity and Contrast

Table 4-14: Nominal Traits — I/O Interface Option

Name	Description
GPIB	Part of Option 14 I/O interface or TD3F14A I/O interface field upgrade kit; complies with IEEE Std 488−1987
RS-232	Part of Option 14 I/O interface or TD3F14A I/O interface field upgrade kit; a 9-pin male DTE RS-232 interface that complies with EIA/TIA 574−90
Centronics	Part of Option 14 I/O interface or TD3F14A I/O interface field upgrade kit; a 25-pin, IBM PC-type, parallel printer interface that complies electrically with Centronics C332−44, Rev A
Video Signal Output (Option 14 Only) (TDS310 and TDS 350, B020100 and above; TDS 320, B030100 and above)	DB-9 rear panel Video connector; non-interlaced, with levels that comply with ANSI RS343A VGA compatible at a 30.6 kHz sync rate
Power Supply, Printer (Option 14 Only) (TDS310 and TDS 350, B020100 and above; TDS 320, B030100 and above)	Power supply connector to supply power to the Option 3P Printer Pack

Table 4-15: Nominal Traits — Power Distribution System

Name	Description
Fuse Rating	5 mm × 20 mm, (UL 198 G): 3 A Slow, 250 V, (IEC 127): 3.15 A (T), 250 V

Table 4-16: Nominal Traits — Safety Characteristics

Name	Description
Safety Certification	Listed UL 1244; Category Certified CAN/CSA−C22.2 No. 231 Series-M89

Table 4-17: Nominal Traits — Mechanical Characteristics

Name	Description
Weight	
Standard Instrument	6.8 kg (15 lbs) stand-alone instrument; 8.4 kg (18.5 lbs) with front cover, accessories, and accessories pouch installed; 12.7 kg (28 lbs) when packaged for domestic shipment
Rackmount Instrument	4.5 kg (10 lbs) for the rackmount conversion kit only; 7.5 kg (17.5 lbs) when kit is packaged for domestic shipment; 6.4 kg (14 lbs), plus weight of rackmount parts, for the rack-mounted instrument (Option 1R); 14.5 kg (32 lbs) when the rackmounted instrument is packaged for domestic shipment
Overall Dimensions	
Standard Instrument (Figure 4-1)	Height: 191 mm (7.5 in) with feet and accessories pouch installed 165 mm (6.5 in) without the accessories pouch installed Width: 362 mm (14.25 in) with handle Depth: 471 mm (18.55 in) stand-alone instrument 490 mm (19.28 in) with front cover installed 564 mm (22.2 in) with handle extended
Rackmount Instrument	Height: 178 mm (7 in) Width: 483 mm (19 in) Depth: 472 mm (18.6 in) without handles; 517 mm (20.35 in) including handles

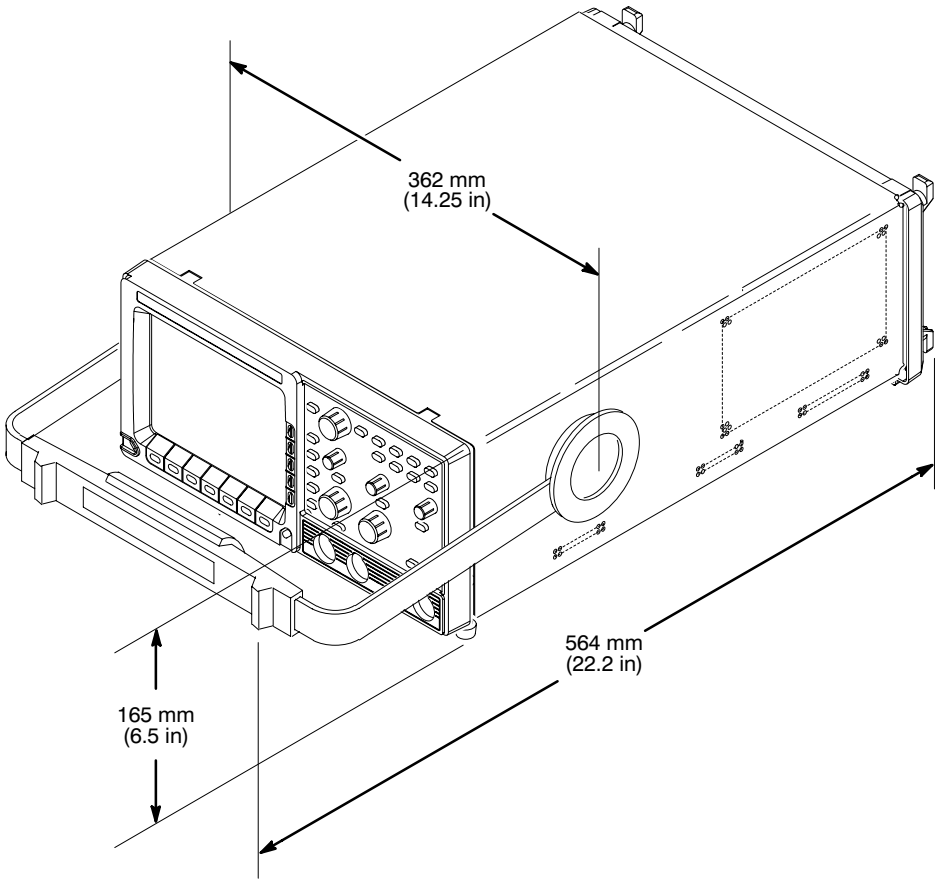


Figure 4-1: TDS 310, TDS 320, and TDS 350 Dimensions

WARNING

The following servicing instructions are for use only by qualified personnel. To avoid personnel injury, do not perform any servicing other than that contained in the operating instructions unless you are qualified to do so. Refer to the Service Safety Summary prior to performing any service.

Theory of Operation

Theory of Operation

This section describes the electrical operation of the TDS 310, TDS 320, and TDS 350 to the module level.

Logic Conventions

This manual refers to digital logic circuits with standard logic symbols and terms. Unless otherwise stated, all logic functions are described using the positive logic convention: the more positive of the two logic levels is the high (1) state and the more negative level is the low (0) state. Signal states may also be described as “true” meaning their active state or “false” meaning their non-active state. The specific voltages that constitute a high or low state vary among the electronic devices.

Active-low signals are indicated by a tilde (~) prefixed to the signal name (~RESET). Signal names are considered to be either active-high, active-low, or to have both active-high and active-low states.

Module Overview

This overview describes the basic operation of each functional circuit block as shown in Figure 5-1.

Input Signal Path

A signal enters the oscilloscope through a probe connected to a BNC on the A1 Main Board.

Attenuators — Circuitry in the attenuator selects the input coupling and attenuation factor. The processor system controls the attenuators with a serial interface.

Probe Coding Interface — The probe coding interface signals pass through the Main Board to the A62 Front Panel, which senses them.

Acquisition System — The acquisition system amplifies the input signals, samples them, converts them to digital signals, and controls the acquisition process under direction of the processor system. The acquisition system includes the trigger, acquisition timing, and acquisition mode generation and control circuitry.

Processor System — The processor system contains a 68331 microprocessor that controls the entire instrument. The processor passes waveforms and text on to the display system. The Main Board contains both the processor and display systems, in addition to the firmware ROMs.

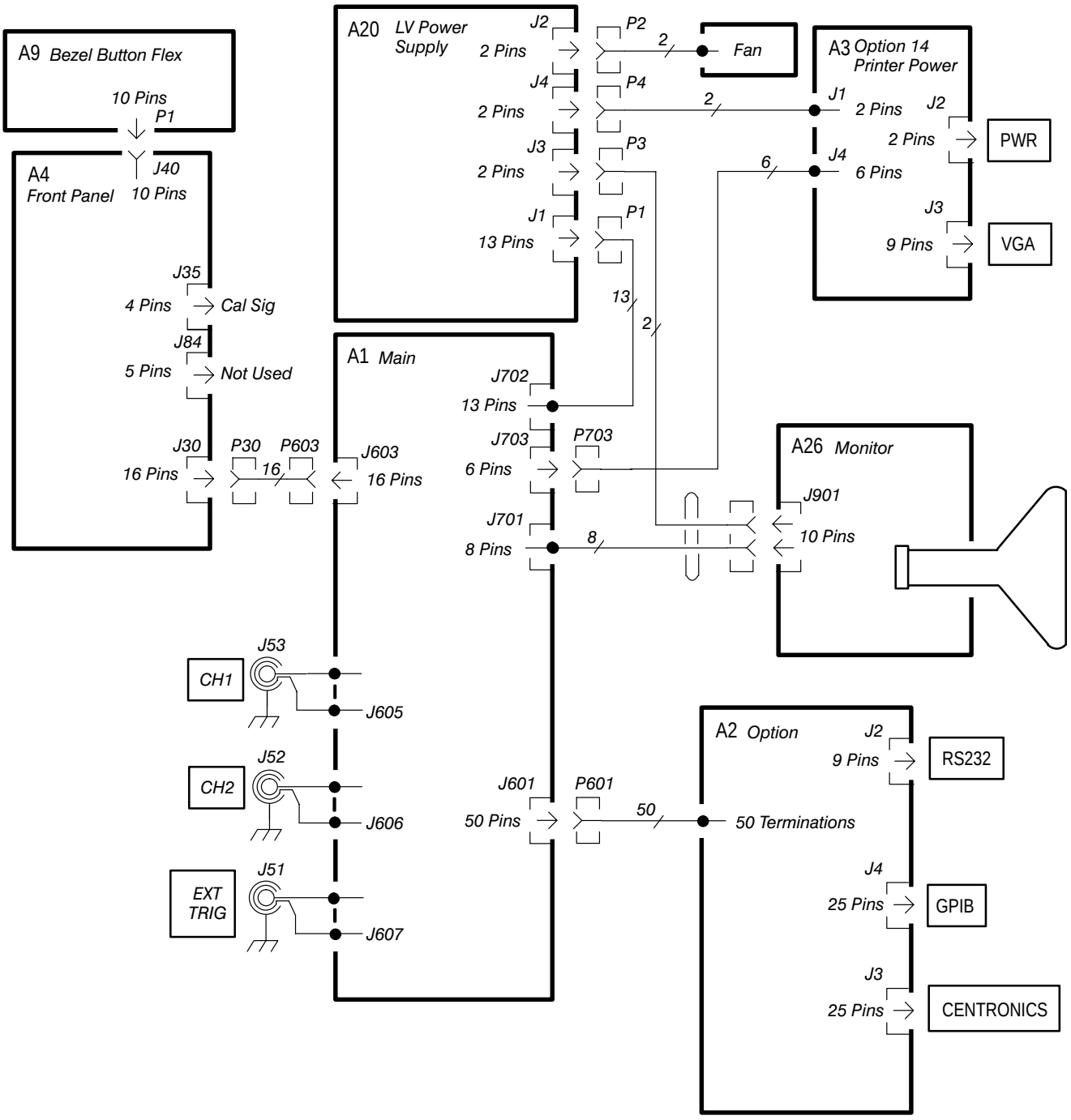


Figure 5-1: TDS 310, TDS 320, and TDS 350 Block Diagram

Display System — A display controller IC processes text and waveforms. The display system sends the text and waveform information to the monitor assembly as a video signal. The display system also generates and sends vertical (VSYNC) and horizontal (HSYNC) sync signals to the monitor assembly.

Monitor Assembly

All information (waveforms, text, graticules, and pictographs) is displayed by the A26 Monitor Assembly. It generates the high voltages necessary to drive the display tube. It also contains the video amplifier, horizontal oscillator, and the vertical and horizontal yoke driver circuitry.

Front Panel

The processor system sends instructions to and receives information from the Front Panel Processor on the Front Panel Board. The Front Panel Processor reads the front-panel switches and ports, and reports any change in their settings to the processor system. The Front Panel Processor also turns the LEDs on and off.

The Front Panel Processor reads the front-panel menu switches and sends any changes in menu selections to the processor system. The **ON**/**STBY** button is not read by the Front Panel Processor but passes through the Front Panel Board and the Main Board to the A20 Low Voltage Power Supply.

The front panel also generates the probe compensation signal.

Communications Option

The A2 Option Board has GPIB, RS-232, and Centronics interfaces for external control and hardcopy operations. Also included are a VGA video output port and a power connector for the Option 3P printer.

Low Voltage Power Supply

The A20 Low Voltage Power Supply is a switching power converter. It supplies power to all the circuitry in the oscilloscope.

The Low Voltage Power Supply does not have a main power switch. The **ON**/**STBY** switch, located on the front panel, controls all the power to the oscilloscope except the standby circuits in the Low Voltage Power Supply.

Fan

The fan provides forced air cooling for the oscilloscope. It connects to a 12 V connector on the Low Voltage Power Supply.

Performance Verification

Performance Verification

These procedures verify the TDS 310, TDS 320, and TDS 350 two channel oscilloscopes. Depending on what you want to accomplish, you may only need to perform a few of these procedures.

- To rapidly confirm that this oscilloscope functions, just do the procedures under *Self Tests*, which begin on page 6-5.

 Advantages: These procedures are quick to do, require no external equipment or signal sources, and perform extensive functional and accuracy testing to provide high confidence that the oscilloscope performs properly. You can use them as a quick check before making a series of important measurements.

- To further check functionality, do the procedures under *Functional Tests* that begin on page 6-7.

 Advantages: These procedures require minimal additional time to perform, require no additional equipment other than a standard-accessory probe, and more completely test the internal hardware of this oscilloscope. You can use them to quickly determine if the oscilloscope is suitable for putting into service, such as when it is first received.

- If you need a more extensive confirmation of performance, do the *Performance Tests*, beginning on page 6-11, after doing the *Functional* and *Self Tests* just referenced.

 Advantages: These procedures add direct checking of warranted specifications. They require more time and suitable test equipment. (See *Equipment Required* on page 6-3.)

Conventions

Throughout these procedures the following conventions apply:

- Each test procedure uses the following general format:

 Title of Test

 Equipment Required

 Time Required

 Prerequisites

 Procedure

- Refer to Figure 6-1: “Main menu” refers to the menu that labels the seven menu buttons under the display. “Side menu” refers to the menu that labels the five buttons to the right of the display. “Pop-up menu” refers to a menu that pops up when a main menu button is pressed.

- Where instructed to use a front-panel button or knob, select from a main or side menu, or verify a readout or status message, the name of the button or knob appears in boldface type.
- Instructions for menu selection follow this format: **FRONT PANEL BUTTON → Pop-Up (if necessary) → Main Menu Button → Side Menu Button**. For example, "Push **TRIGGER MENU → Type: Video → Trigger On → Any Line**."

STOP This symbol denotes information you must read to do the procedure properly.

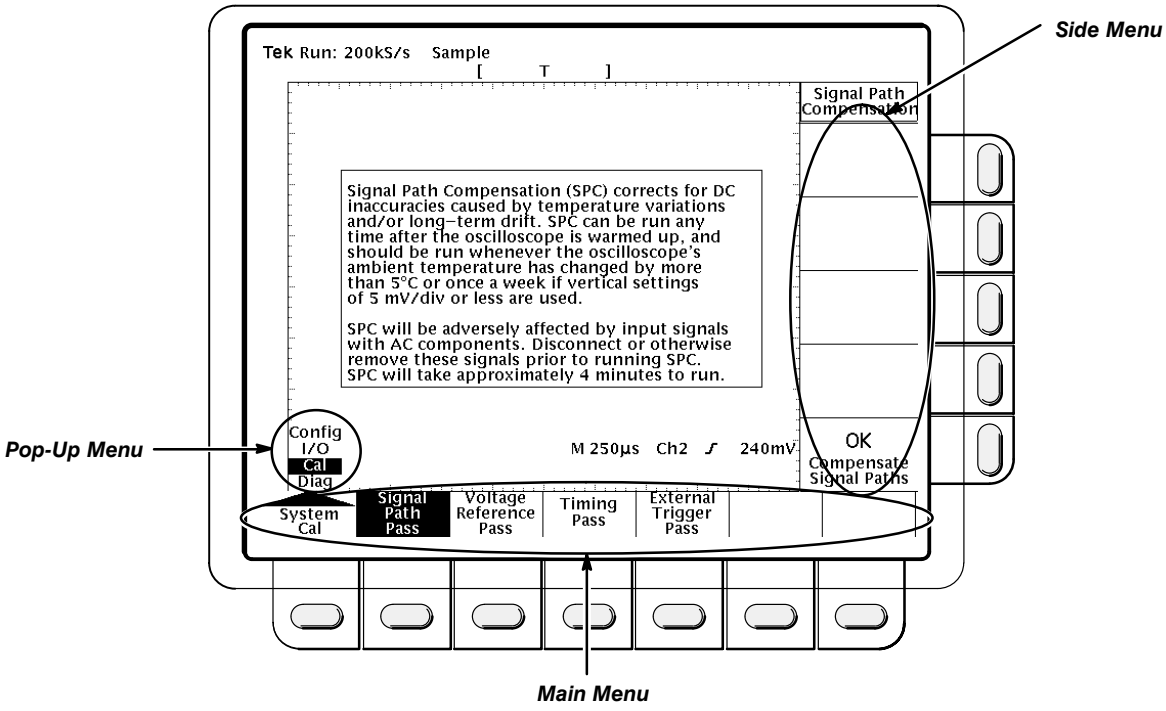


Figure 6-1: Menu Locations

Test Equipment

These procedures use external, traceable signal sources to directly check instrument performance. If your test equipment does not meet the minimum requirements listed in Table 6-1, your test results will be invalid.

Table 6-1: Test Equipment

Item Number and Description		Minimum Requirements	Example	Purpose
1	Termination 50 Ω (two required)	Impedance 50 Ω; connectors: female BNC input, male BNC output	Tektronix part number 011-0049-01	Checking delay between channels
2	Cable, Precision Coaxial (two required)	50 Ω, 91 cm (36 in), male to male BNC connectors	Tektronix part number 012-0482-00	Signal interconnection
3	Connector, Dual-Banana	Female-BNC to dual-banana	Tektronix part number 103-009-00	Several accuracy tests
4	Connector, BNC "T"	Male-BNC to dual-female-BNC	Tektronix part number 103-0030-00	Checking trigger sensitivity
5	Coupler, Dual-Input	Female-BNC to dual-male-BNC	Tektronix part number 067-0525-02	Checking delay between channels
6	Generator, DC Calibration	Variable amplitude to ±110 V; accuracy to 0.1%	Data Precision 8200	Checking DC offset, gain, and measurement accuracy
7	Generator, Leveled Sine Wave, Medium-Frequency	200 kHz to 250 MHz; variable amplitude from 5 mV to 4 V_{p-p} into 50 Ω	TEKTRONIX SG 503 Leveled Sine Wave Generator	Checking trigger sensitivity at low frequencies
8	Generator, Time Mark	Variable marker frequency from 10 ms to 10 ns; accuracy within 2 ppm	TEKTRONIX TG 501A Time Mark Generator	Checking sample rate and delay-time accuracy
9	Probe, 10X, included with this instrument	A P6109B (TDS 310 and TDS 320) or P6111B (TDS 350) probe	Tektronix number P6109B (TDS 310 and TDS 320) or P6111B (TDS 350)	Signal interconnection

Test Record

Photocopy the next page and use it to record the performance test results for your instrument.

TDS 310, TDS 320, and TDS 350 Test Record

Instrument Serial Number: _____ Certificate Number: _____
Temperature: _____ RH %: _____
Date of Calibration: _____ Technician: _____

Performance Test		Minimum	Incoming	Outgoing	Maximum
DC Voltage Measurement Accuracy					
CH1 VOLTS/DIV1 V		+97.1 V	_____	_____	+98.9 V
	200 mV	+8.28 V	_____	_____	+8.52 V
	50 mV[1]	−581 mV	_____	_____	−619 mV
	50 mV[2]	−881 mV	_____	_____	−919 mV
	Δ at 50 mV	+286 mV	_____	_____	+314 mV
	10 mV	+54.6 mV	_____	_____	+65.4 mV
	5 mV	−982 mV	_____	_____	−998 mV
CH2 VOLTS/DIV1 V		+97.1 V	_____	_____	+98.9 V
	200 mV	+8.28 V	_____	_____	+8.52 V
	50 mV[1]	−581 mV	_____	_____	−619 mV
	50 mV[2]	−881 mV	_____	_____	−919 mV
	Δ at 50 mV	+286 mV	_____	_____	+314 mV
	10 mV	+54.6 mV	_____	_____	+65.4 mV
	5 mV	−982 mV	_____	_____	−998 mV
Analog Bandwidth					
CH1		42.5 mV	_____	_____	N/A
CH2		42.5 mV	_____	_____	N/A
Long Term Sample Rate and Delay Time Accuracy					
		−2.0 Div	_____	_____	+2.0 Div
Edge Trigger Sensitivity, DC Coupled					
Main Trigger		stable trigger	_____	_____	N/A
Main Trigger − Falling		stable trigger	_____	_____	N/A

[1] **Generator set at −0.6 V.**

[2] **Generator set at −0.9 V.**

Self Test

This procedure uses internal routines to verify that the oscilloscope functions and passes its internal self tests and signal path compensations. It also confirms that the oscilloscope was adjusted properly at the time it was last adjusted. No test equipment or hookups are required.

Equipment Required: None.

Time Required: Approximately 5 minutes.

Prerequisites: Power up the oscilloscope and allow a 20 minute warm-up before doing this procedure.

Procedure:

1. Press **UTILITY** → **System: Diag** → **Execute** → **OK Confirm Run Test**. The internal diagnostics verify proper oscilloscope function. This verification takes about 30 seconds. While it progresses, a variety of test patterns flash on screen. When finished, status messages appear on the screen.
2. Check that the screen reports no failures. If it reports a failure, the instrument has failed the self test. Proceed immediately to the troubleshooting procedure on page 8-29.
3. Press **CLEAR MENU**.
4. Press **UTILITY** → **System: Cal**.
5. Check that the word ***Pass*** appears in the main menu under the **Voltage Reference**, **Timing**, and **Ext Trig** menu labels. (See Figure 6-2.) If any of the labels read ***Fail***, the instrument has failed the self test. Proceed immediately to the system calibration procedure on page 7-2.

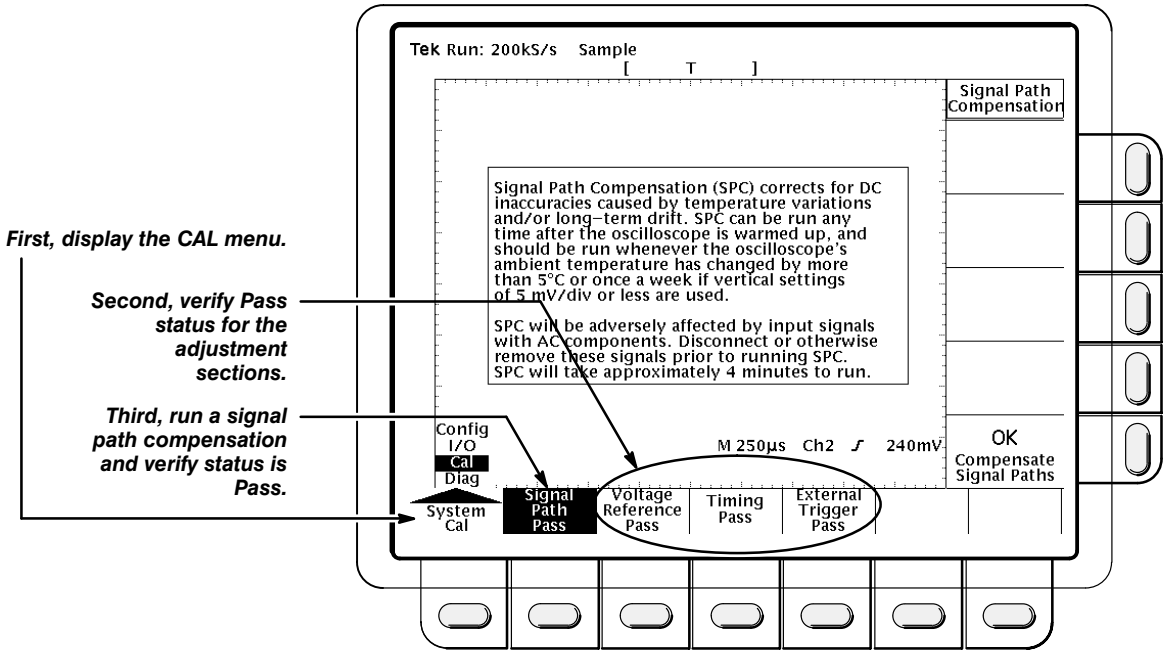


Figure 6-2: Verifying Adjustments and Signal Path Compensation

6. Press **Signal Path → OK Compensate Signal Paths**. When compensation completes, the status message updates to *Pass* or *Fail* in the main menu
7. Check that the word ***Pass*** appears under **Signal Path** in the main menu. (See Figure 6-2.) If ***Pass*** does not appear, the instrument has failed the performance verification; return it to Tektronix for servicing.

Functional Test

The purpose of this procedure is to confirm that the oscilloscope functions properly.



This procedure verifies functions; that is, it verifies that oscilloscope features *operate*. It does *not* verify that they operate within limits.

Therefore, when the instructions that follow call for you to verify that a signal appears on-screen "that is about five divisions in amplitude" or "has a period of about six horizontal divisions," etc., do *NOT* interpret the quantities given as limits. Operation within limits is checked in *Performance Tests*, which begin on page 6-11.



DO NOT make changes to the front-panel settings that are not called out in the procedure. If you make changes to these settings other than those called out in the procedure, you may obtain invalid results. In this case, just redo the procedure from step 1.

NOTE

If the oscilloscope fails any of these checks it has failed the performance verification. To diagnose the causes of a failure, proceed to the troubleshooting procedures on page 8-27.

Equipment Required: One P6109B (TDS 310 and TDS 320) or P6111B (TDS 350) probe (Item 9).

Time Required: Approximately 5 minutes.

Prerequisites: None.

Procedure:

1. Install the probe on **CH 1**. Connect the probe tip to **PROBE COMP** on the front panel; leave the probe ground unconnected. (See Figure 6-3.)

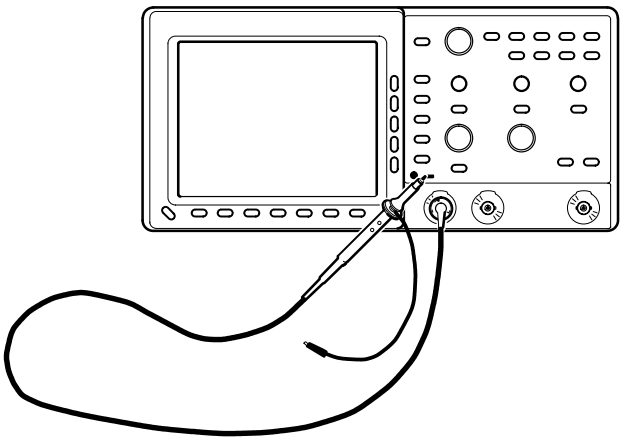


Figure 6-3: Hookup for Functional Test

2. Press **SAVE**/**RECALL SETUP** → **Recall Factory Setup** → **OK Confirm Factory Init**.
3. Press **AUTOSET**.
4. Set the **VOLTS**/**DIV** to 1 V. Use the vertical **POSITION** knob to center the waveform vertically on screen.
5. Set the **SEC**/**DIV** to 250 µs.
6. Check that a square-wave probe-compensation signal of about five divisions in amplitude is on screen. (See Figure 6-1 on page 6-2 to locate the readout.)
7. Check that one period of the square wave probe-compensation signal is about four horizontal divisions on screen.
8. Check that the horizontal **POSITION** knob positions the signal left and right on screen when rotated.
9. Press **TRIGGER MENU** → **Mode** → **Normal**.
10. Check that the trigger level readout for the main trigger system changes with the trigger **LEVEL** knob.
11. Check that the trigger-level knob can trigger and untrigger the square-wave signal as you rotate it. (Leave the signal *un*triggered.)
12. Check that pressing **SET LEVEL TO 50%** triggers the signal that you just left untriggered.
13. Press **ACQUIRE** → **Mode** → **Sample**.
14. Check that the instrument displays an actively acquiring waveform on-screen. (Note that there is noise present on the peaks of the square wave.)
15. Press the side menu button **Peak Detect**. Check that the instrument displays an actively acquiring waveform on screen with the noise “peak detected.”

16. Press the side menu button **Envelope**. Check that the instrument displays an actively acquiring waveform on screen with the noise displayed.
17. Press the side menu button **Average**. Check that the instrument displays an actively acquiring waveform on screen with the noise reduced.
18. Press **WAVEFORM OFF** to remove Channel 1 from the display.
19. Press **CH 2** and move the probe to the **CH 2** input.
20. Repeat steps 3 through 17 for Channel 2.
21. Disconnect the probe from the channel input and the **PROBE COMP** terminal.

Performance Tests

The procedures are in three groupings: *Signal Acquisition System Checks, Time Base System Checks,* and *Triggering System Checks*. They check all the characteristics that appear in **boldface** type under *Warranted Characteristics* on page 4-3.

Prerequisites

The tests in this subsection comprise an extensive, valid confirmation of performance and functionality when the following requirements are met:

- The cabinet must be installed.
- You must have performed and passed the procedures under *Self Tests,* on page 6-5 and those under *Functional Tests,* on page 6-7.
- The digitizing oscilloscope must have been operating for a warm-up period of at least 20 minutes, and must be operating at an ambient temperature between −10° C and +55° C.

Signal Acquisition System Checks

These procedures check signal acquisition system characteristics that are listed as checked under *Warranted Characteristics* in the *Specifications* section.

Check DC Voltage Measurement Accuracy

WARNING

Performance of this procedure requires input voltages up to 98 VDC. Contact with live circuits could cause injury or death. Be sure to set the DC calibration generator to 0 volts before connecting, disconnecting, and/or moving the test hookup during the performance of this procedure.

Equipment Required: One dual-banana connector (Item 3), one DC calibration generator (Item 6), and one precision coaxial cable (Item 2).

Time Required: Approximately 35 minutes.

Prerequisites: The oscilloscope must meet the prerequisites listed on page 6-11.

Procedure:

1. Set the output of a DC calibration generator to 0 volts.

2. Connect the output of a DC calibration generator through a dual-banana connector followed by a 50 Ω precision coaxial cable to **CH 1**, as shown in Figure 6-4.

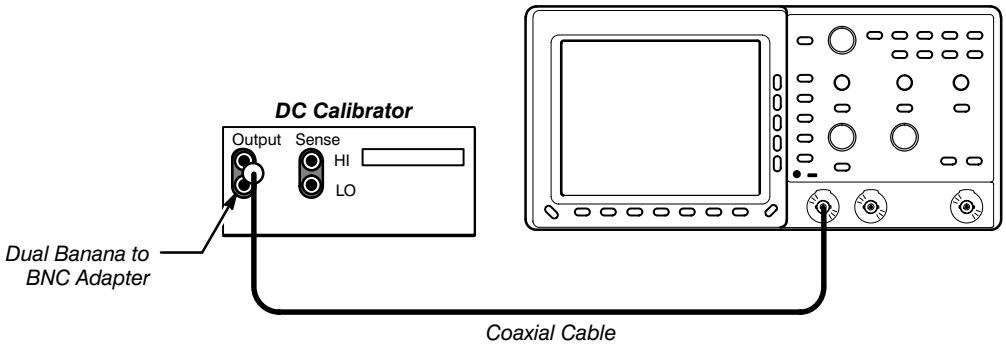


Figure 6-4: Hookup for DC Voltage Measurement Accuracy Check

3. Press **SAVE/RECALL SETUP → Recall Factory Setup → OK Confirm Factory Init**.
4. Press **ACQUIRE → Mode → Average 16**.
5. Press **MEASURE → Select Measurement**.
6. Press the side menu button **more** until the menu label **Mean** appears in the side menu. Press the side menu button **Mean**.
7. Set the **VOLTS/DIV** to one of the settings listed in Table 6-2 that you have not yet checked. (Start with the first setting listed.)
8. Press **VERTICAL MENU → Position**.

Table 6-2: DC Accuracy

Scale Setting	Position Setting (Divs)	Offset Setting	Generator Setting	Accuracy Limits
1 V	+5	+100 V	+98 V	+97.1 V to +98.9 V
200 mV	+5	+10 V	+8.4 V	+8.28 V to +8.52 V
50 mV	−5	−1 V	−0.6 V	−581 mV to −619 mV
50 mV	−5	−1 V	−0.9 V	−881 mV to −919 mV
△ at 50 mV				+286 mV to +314 mV
10 mV	−5	0 V	+60 mV	+54.6 mV to +65.4 mV
5 mV	0	−1 V	−990 mV	−982 mV to −998 mV

9. Turn the **General Purpose Knob** to set the vertical position to the setting listed in Table 6-2. The baseline level moves off screen.
10. Press the main menu button **Offset**.
11. Use the **General Purpose Knob** to set vertical offset to the setting listed in Table 6-2 for the present vertical scale setting. The baseline level remains off screen.
12. Set the generator to the level and polarity indicated in Table 6-2 for the vertical scale, position, and offset settings you have made. The DC test level should appear on screen. (If it does not return, the DC accuracy check has failed for the present vertical scale setting of the current channel.)
13. Check that the readout for the measurement **Mean** readout on screen is within the limits listed for the present vertical scale and position/offset/generator settings.
14. Repeat steps 7 through 13 until you have checked all the vertical scale settings listed in Table 6-2. Record the measurements for each of the 50 mV settings.
15. Subtract the second 50 mV measurement from the first and compare the result to the "△ at 50 mV" limits in Table 6-2.
16. Press **WAVEFORM OFF**; then, press **CH 2**.
17. Set the generator output to 0 V.
18. Move the test hookup to the **CH 2** input.
19. Repeat steps 5 through 15 for channel 2.
20. Set the generator output to 0 V.
21. Disconnect the cable at the **CH 2** input connector.

DC Gain Accuracy

DC gain accuracy is verified by successful completion of the self tests and the DC voltage measurement accuracy (in the previous procedure).

Offset Accuracy

Offset accuracy is verified by successful completion of the Self Tests and the DC voltage measurement accuracy (in the previous procedure).

Check Analog Bandwidth

Equipment Required: One medium-frequency leveled sine wave generator (Item 7), one 50 Ω precision cable (Item 2), and one 50 Ω termination (Item 1).

Time Required: Approximately 20 minutes.

Prerequisites: *See page 6-11.*

Procedure:

1. Connect, through a 50 Ω precision cable and a 50 Ω termination, the sine wave output of a medium-frequency leveled sine wave generator to **CH 1** (see Figure 6-5). Set the output of the generator to a reference frequency of 50 kHz.

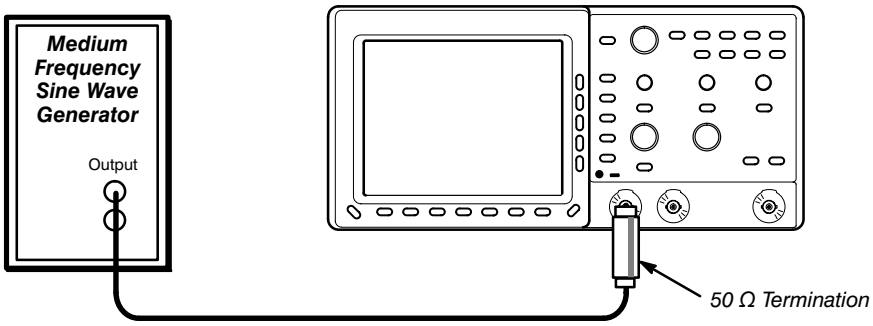


Figure 6-5: Hookup for Analog Bandwidth Check

1. Press **SAVE/RECALL SETUP → Recall Factory Setup → OK Confirm Factory Init**.
2. Set the **SEC/DIV** to 10 μs.
3. Press **TRIGGER MENU → Coupling → Noise Rej**.
4. Press **ACQUIRE → Mode → Average 16**.
5. Press **MEASURE → High−Low Setup → Min−Max**.
6. Press the main menu button **Select Measurement**. Now press the side menu button **more** until the menu label **Pk-Pk** appears in the side menu. Press the side menu button **Pk-Pk**.
7. Set the **VOLTS/DIV** to 10 mV.
8. Set the generator output so the **CHx Pk-Pk** readout equals 60 mV.
9. Press **SET LEVEL TO 50%** as necessary to trigger the display.
10. Increase the frequency of the generator output to 50 MHz (TDS 310), 100 MHz (TDS 320), or 200 MHz (TDS 350).
11. Set the **SEC/DIV** to 10 ns (TDS 310), 5 ns (TDS 320), or 2.5 ns (TDS 350).
12. Press **SET LEVEL TO 50%** as necessary to trigger the display.
13. Check that the **Pk-Pk** readout on screen (as shown in Figure 6-6) is ≥42.5 mV.

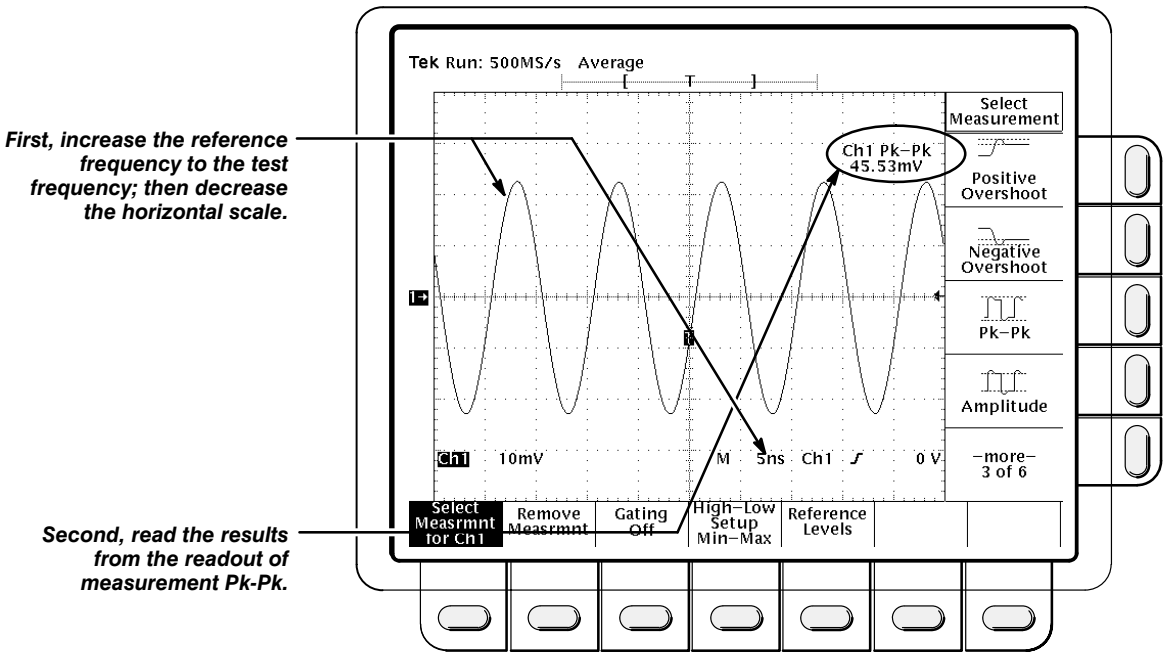


Figure 6-6: Measuring Analog Bandwidth

14. When finished checking, set the **SEC**/**DIV** back to the 10 µs setting, and set the generator output frequency back to 50 kHz.
15. Press **WAVEFORM OFF** to remove Channel 1 from the display.
16. Press **CH 2** and move the hookup to the **CH 2** input.
17. Press **TRIGGER MENU** → **Source** → **CH 2**.
18. Repeat steps 6 through 13 for **CH 2**.
19. Disconnect the test hook up from the **CH 2** input connector.

Time Base System Checks

This procedure checks those characteristics that relate to the Main and Delayed time base system and are listed as checked under *Warranted Characteristics* in the *Specifications* section.

Check Long-Term Sample Rate and Delay Time Accuracy

Equipment Required: One time-marker generator (Item 8), one precision coaxial cable, (Item 2) and one 50 Ω termination (Item 1).

Time Required: Approximately 5 minutes.

Prerequisites: *See page 6-11.*

Procedure:

1. Connect, through a 50 Ω precision coaxial cable and a 50 Ω termination, the time-mark output of a time-marker generator to **CH 1**, as shown in Figure 6-7. Set the output of the generator for 10 ms markers.

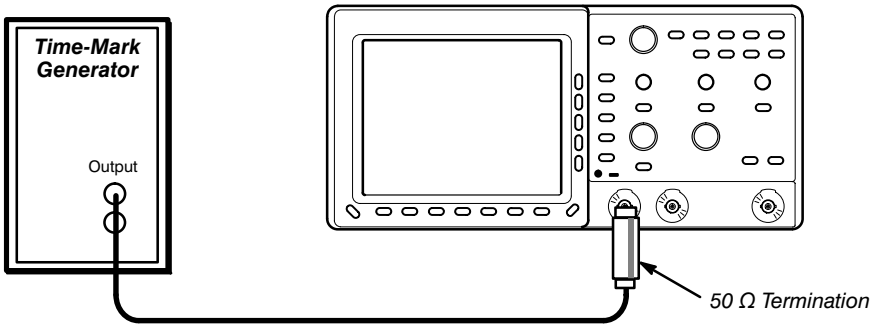


Figure 6-7: Hookup for Sample Rate Check

2. Press **SAVE**/**RECALL SETUP** → **Recall Factory Setup** → **OK Confirm Factory Init**.
3. Set the **VOLTS**/**DIV** to 500 mV.
4. Press **SET LEVEL TO 50%**; use the vertical **POSITION** knob to center the test signal on screen.
5. Set the **SEC**/**DIV** to 1 ms.
6. Press **HORIZONTAL MENU** → **Trigger Position** → **Set to 10%**.
7. Adjust the horizontal **POSITION** to move the trigger **T** to the right and on to the screen. Continue to position the trigger **T** to align it to the center vertical graticule line.
8. Press the main menu button **Time Base**; then press the side menu button **Delayed Only**.

9. Set the **SEC**/**DIV** of the **D** (delayed) time base to 1 ms. Then use the **General Purpose** knob to set delay time to 10 ms.
10. Set the **SEC**/**DIV** of the **D** (delayed) time base to 500 ns.

NOTE

*When you change the **SEC**/**DIV** in step 10, the delay time readout changes to 10.00001 or 9.99999. This is normal and has no effect on the verification*

11. Check that the rising edge of the marker crosses the center horizontal graticule line at a point within ±2.0 divisions of center graticule.
12. Disconnect the test hookup.

Delta Time Measurement Accuracy

Delta time measurement accuracy is verified by successful completion of the previous procedure.

Trigger System Checks

These procedures check those characteristics that relate to the trigger system and are listed as checked under *Warranted Characteristics* in the *Specifications* section.

Check Edge Trigger Sensitivity, DC Coupled

Equipment Required: One medium-frequency leveled sine wave generator (Item 7), two precision 50 Ω coaxial cables (Item 2), one 50 Ω termination (Item 1), and one BNC T connector (Item 4).

Time Required: Approximately 10 minutes.

Prerequisites: *See page 6-11.*

Procedure:

1. Press **SAVE**/**RECALL SETUP** → **Recall Factory Setup** → **OK Confirm Factory Init**.
2. Set the **VOLTS**/**DIV** to 500 mV.
3. Set the **SEC**/**DIV** to 10 ns.
4. Press **TRIGGER MENU** → **Mode** → **Normal**.
5. Press **ACQUIRE** → **Mode** → **Average 16**.
6. Connect one 50 Ω cable to the output of the sine wave generator. Attach a BNC T connector to the other end of the cable. Connect a second 50 Ω cable to the other side of the BNC T connector.

7. Connect the BNC T connector to **CH 1**; connect the cable to the **EXT TRIG** input through a 50 Ω termination as shown in Figure 6-8.

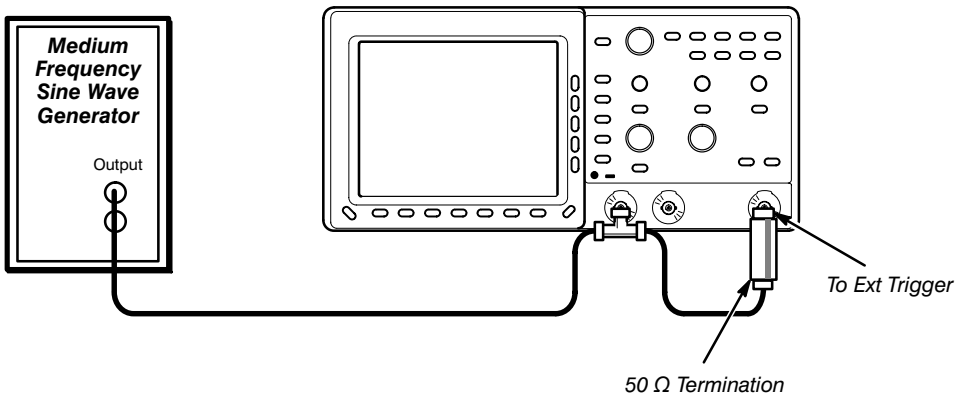


Figure 6-8: Hookup for Trigger Sensitivity Check

8. Set the generator frequency to 50 MHz (TDS 310), 100 MHz (TDS 320), or 200 MHz (TDS 350).
9. Press **MEASURE** → **High-Low Setup** → **Min-Max**.
10. Press the main menu button **Select Measurement**.
11. Press the side menu button **−more−** until **Amplitude** appears in the side menu. Press the side menu button **Amplitude**.
12. Press **SET LEVEL TO 50%**.
13. Set the test signal amplitude for about one division on screen. Fine adjust the generator output until the **CH 1 Amplitude** readout indicates the amplitude is 500 mV. (Readout may fluctuate around 500 mV.)
14. Press **TRIGGER MENU** → **Slope**.
15. Press **SET LEVEL TO 50%**. Check that a stable trigger is obtained for the test waveform on both the positive and negative slopes (see Figure 6-9). (Use the side menu to switch between trigger slopes; use the trigger **LEVEL** knob to stabilize the trigger if required.)

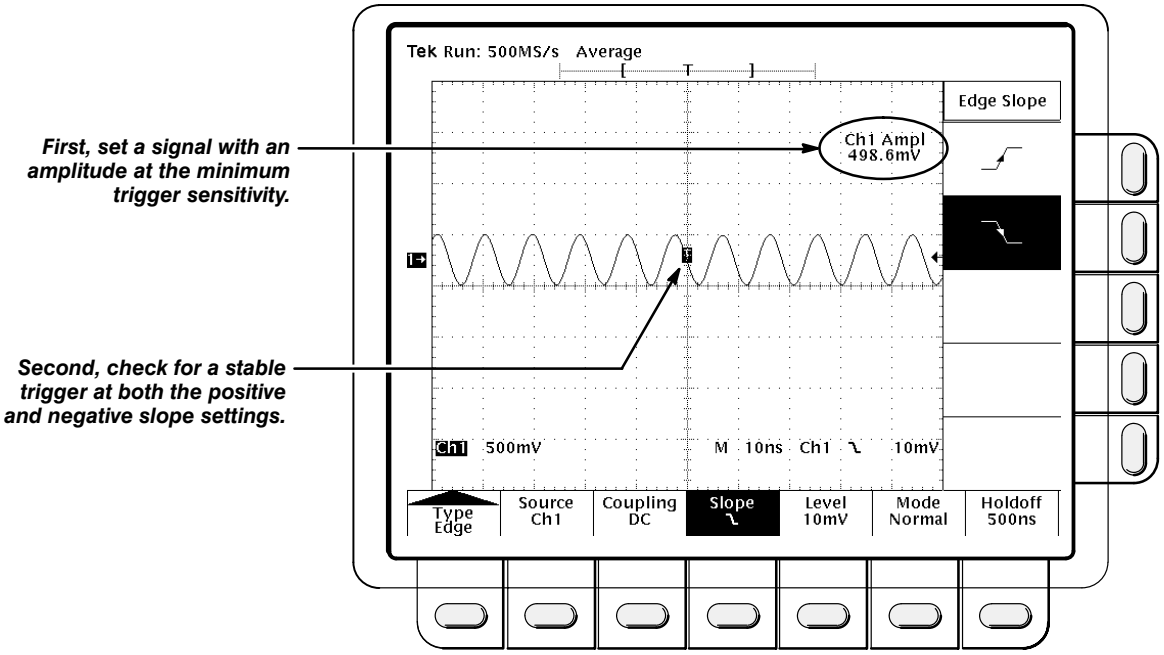


Figure 6-9: Measuring Trigger Sensitivity

16. Press **WAVEFORM OFF**.
17. Press **CH 2**.
18. Press **TRIGGER MENU** → **Source** → **Ch2**.
19. Disconnect the hookup from **CH 1** and connect it to **CH 2**.
20. Set the **VOLTS**/**DIV** to 500 mV.
21. Repeat steps 14 and 15 for Channel 2.
22. Press **TRIGGER MENU** → **Source** → **EXT**/**10**.
23. Press **MEASURE** → **Select Measrmnt** → **Amplitude**.
24. Increase the generator amplitude until the amplitude measurement reads 1.5 V.
25. Repeat steps 14 and 15 for the external trigger.
26. Disconnect the test hookup.

Trigger Level Accuracy, DC Coupled

Trigger level accuracy is verified by the successful completion of the Self Tests and the DC voltage measurement accuracy procedure on page 6-11.

Adjustment Procedures

Adjustment

This section contains information you need to adjust the TDS 310, TDS 320, and TDS 350. There are only three types of adjustments you can perform on the oscilloscope: the automated and semiautomated adjustments in the system calibration menu, attenuator adjustments, and monitor adjustments.

You should perform the signal path compensation adjustment after servicing your instrument or moving your instrument to a new operating environment (±5° C temperature change). The other adjustment procedures may be necessary if the instrument fails one of the *Performance Tests* in the previous section.

You should allow the instrument a 20 minute warm-up period before performing any adjustments.

Adjustment Interval — These adjustments should be done once a year.

Equipment Required

Table 7-1: Adjustment Equipment

Item Number and Description		Minimum Requirements	Example	Purpose
1	Adjustment Tool	0.075 inch slot screwdriver	Tektronix part number 003-1433-01 (standard probe adjustment tool)	Monitor and attenuator adjustments
2	Termination, 50 Ω	Impedance 50 Ω; connectors: female BNC input, male BNC output	Tektronix part number 011-0049-01	Timing calibration and attenuator adjustment
3	Cable, Precision Coaxial	50 Ω, 36 in, male to male BNC connectors	Tektronix part number 012-0482-00	Attenuator adjustments and system calibration
4	Generator, DC Calibration	Variable amplitude to ±10 V; accuracy to 0.05%	Data Precision 8200	Voltage and external trigger calibrations
5	Generator, Calibration	Variable amplitude; fast rise step	Tektronix PG506A Calibration Generator	Timing calibration and attenuator adjustment

The System Calibration Menu

The oscilloscope has four onboard calibration routines. You can access these routines through the system calibration menu. Use the following procedure.

NOTE

Except for early TDS 320 oscilloscopes, the Voltage, Timing, and External Trigger calibration routines are disabled at the factory. To enable the calibration menus, see Enabling Calibration Menus, *on page 8-29.*

1. Press **UTILITY**.
2. Press the leftmost main menu button until the pop-up menu shows the **Cal** selection. This calls up the system calibration menu, shown in Figure 7-1.

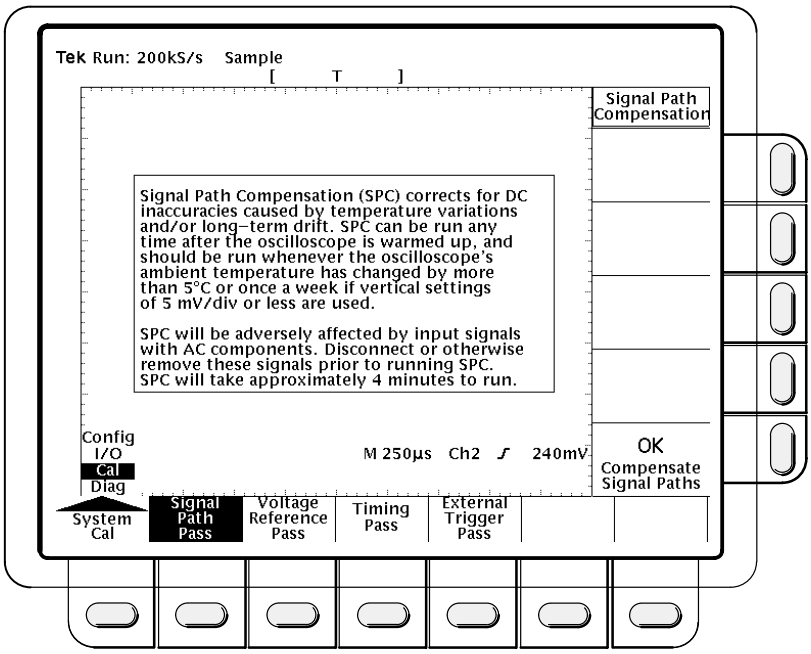


Figure 7-1: The System Calibration Menu

3. Remove all input signals from the front panel BNC connectors.
4. Press the main menu button **Voltage**. Read the on-screen text before continuing.
5. Press the side menu button **OK Calibrate Voltage Ref**. Connect a DC calibration generator (Item 4) to the **CH 1** input through a 50 Ω coaxial cable (Item 3) and follow the instructions on the screen.
6. Press **UTILITY**.

7. Press the main menu button **Signal Path**. Read the on-screen text before continuing.
8. Press the side menu button **OK Compensate Signal Paths**.
9. Wait. The signal path compensation routine takes about four minutes to run.
10. Move the hookup to the **EXT TRIG** input.
11. Press **UTILITY**.
12. Press the main menu button **Ext Trig**. Read the on-screen text before continuing.
13. Press the side menu button **OK Calibrate External Trig**. Follow the instructions on the screen.
14. Disconnect the DC calibration generator and connect the −1 V fast rise output of a calibration generator to the **CH 1** input through a 50 Ω coaxial cable and a 50 Ω termination (Item 2).
15. Set the calibration generator to output a 1 ms, fast rise signal; set the pulse amplitude to 50%.
16. Press **SAVE/RECALL SETUP**. Press the main menu button **Recall Factory Setup**; then press the side menu button **OK Confirm Factory Init**.
17. Press **AUTOSET**. Then adjust the vertical **POSITION** control to center the waveform on the screen so that the trigger arrow is at the center graticule, set the **VOLTS/DIV** to 50 mV, and set the **SEC/DIV** to 250 ns. This should result in a waveform similar to the one shown in Figure 7-2.

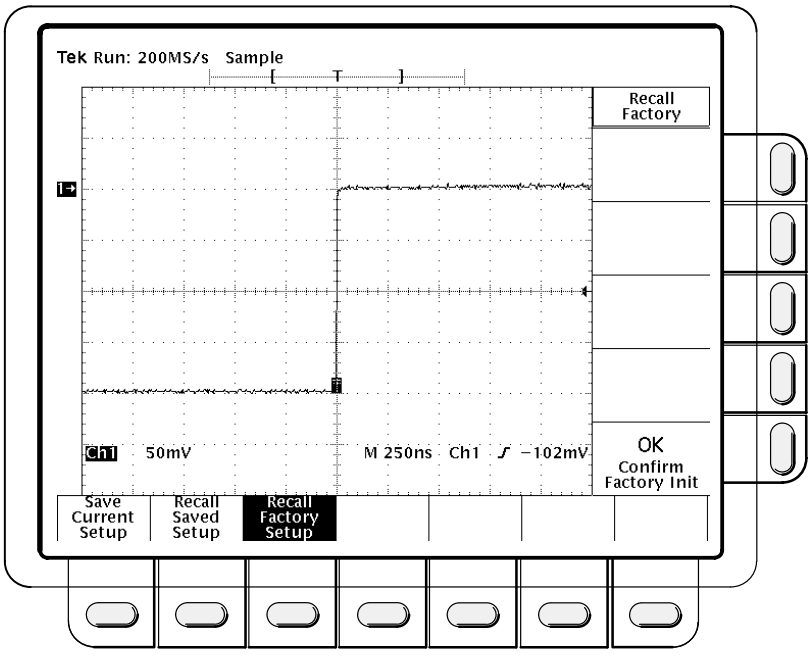


Figure 7-2: Timing Compensation Waveform

18. Press **UTILITY**.
19. Press the main menu button **Timing**. Read the on-screen text before continuing.
20. Press the side menu button **OK Compensate Timing**. Follow the instructions on the screen.

Attenuator Adjustment

Use this procedure to adjust the low-frequency compensation of the channel 1 and channel 2 attenuators. You should perform this procedure if your oscilloscope demonstrates gross rounding or overshoot of square-wave input signals or if your instrument fails one of the *Performance Tests* in the previous section.

1. Remove the instrument cabinet as described in the removal procedure on page 8-13.
2. Set the oscilloscope on its left side with its front facing toward you.
3. Power up the oscilloscope and press **SAVE**/**RECALL SETUP**.
4. Press the main menu button **Factory**; then press the side menu button **OK Confirm Factory Init**.
5. Press **CLEAR MENU**.
6. Connect the high output of a calibration generator (Item 5) to the **CH 1** BNC through a 50 Ω coaxial cable (Item 3) and a 50 Ω termination (Item 2). (See Figure 7-3.)
7. Set the calibration generator to output a high amplitude, 1 kHz signal. Set the pulse amplitude to 25%.
8. Set the oscilloscope **VOLTS**/**DIV** to 200 mV, the **SEC**/**DIV** to 10 µs, and adjust the pulse amplitude for a five division display.
9. Press **SET LEVEL TO 50%**.
10. Use the vertical **POSITION** control to place the top of the waveform near center screen.
11. Set the **VOLTS**/**DIV** to 100 mV.
12. Use an adjustment tool (Item 1) to adjust the CH 1 10X capacitor for the flattest response. (See Figure 7-3.)
13. Remove the 50 Ω termination from the setup.
14. Set the **VOLTS**/**DIV** to 2 V.
15. Press **SET LEVEL TO 50%**.

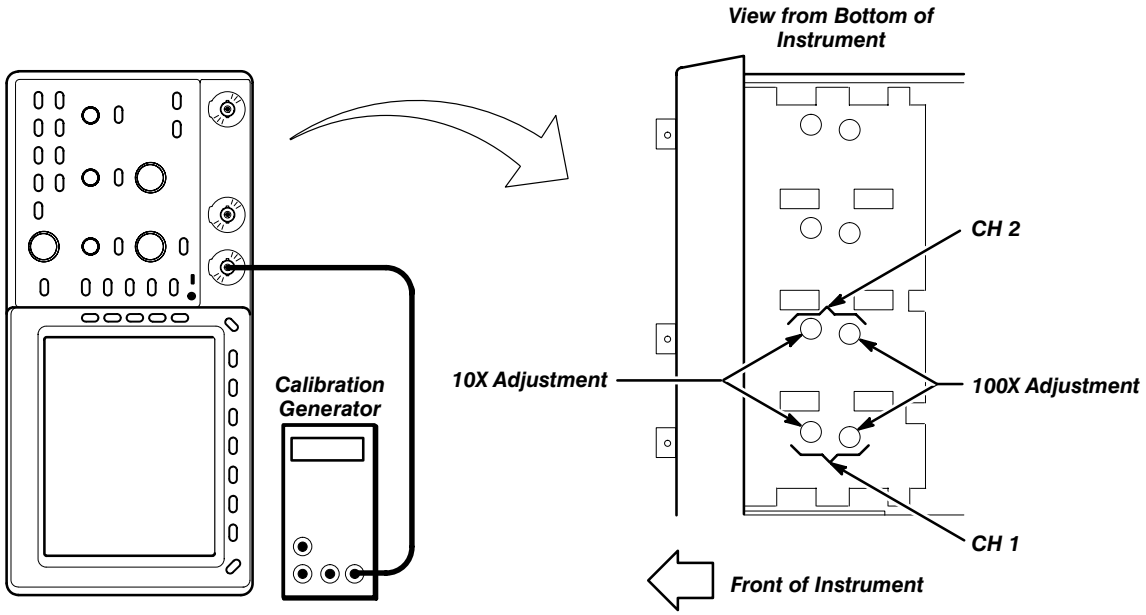


Figure 7-3: Attenuator Adjustment Setup and Locations

16. Adjust the pulse amplitude for a five-division display.
17. Set the **VOLTS**/**DIV** to 1 V.
18. Use an adjustment tool to adjust the CH 1 100X capacitor for the flattest response.
19. Press **WAVEFORM OFF**, **CH 2**, and **TRIGGER MENU**, *in that order*.
20. Press the main menu button **SOURCE**; then press the side menu button **Ch2**.
21. Move the coaxial cable to the **CH 2** BNC input, reinstalling the 50 Ω termination.
22. Repeat steps 7 through 18 for channel 2.
23. Reinstall the instrument cabinet.

Monitor Adjustments

There are no set performance requirements for the monitor. You may use this procedure to change monitor parameters whenever the brightness, contrast, horizontal position, or vertical position of the display is not to your liking.

1. Remove the instrument cabinet as described in the removal procedure on page 8-13.
2. Set the oscilloscope bottom-down with its front facing toward you.
3. Turn on the oscilloscope and allow a 20 minute warm-up period.
4. Press **DISPLAY**.

5. Press the main menu button **Intensity**. Use the side menu to set overall intensity to 100%, **Text**/**Grat** to bright, and **Waveform** to bright.
6. Locate the brightness potentiometer (see Figure 7-4). Use an adjustment tool (Item 1) to raise the brightness until the background of the screen turns green.

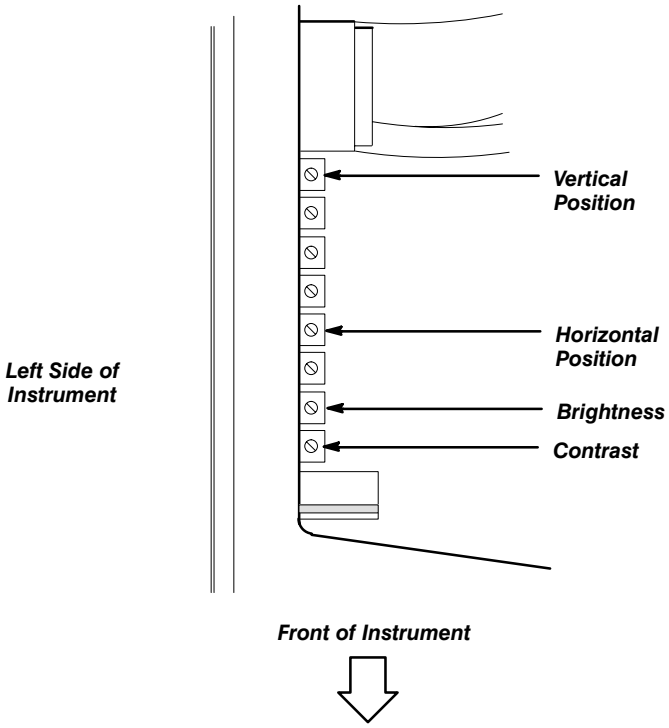


Figure 7-4: Monitor Adjustments

7. Now lower the brightness *just beyond the point* where the background fades to black.
8. Locate the contrast potentiometer. Adjust the contrast to your taste.

NOTE

The higher the contrast, the higher the likelihood that prolonged use will cause CRT burn-in.

9. Locate the vertical position potentiometer. Adjust the vertical position until the display is vertically centered on the screen.
10. Locate the horizontal position potentiometer. Adjust the horizontal position until the display is horizontally centered on the screen.

Maintenance

Inspection and Cleaning

Inspection and Cleaning describes how to inspect for dirt and damage on and how to clean the exterior and interior of the oscilloscope. You should perform inspection and cleaning as preventive maintenance. Preventive maintenance, when done regularly, may prevent oscilloscope malfunction and enhance its reliability.

Preventive maintenance consists of visually inspecting and cleaning the oscilloscope and using general care when operating it.

How often to do maintenance depends on the severity of the environment in which you use the oscilloscope. A proper time to perform preventive maintenance is just before oscilloscope adjustment.

Preventing ESD

CAUTION

Static discharge can damage any semiconductor component in this oscilloscope.

Precautions

When performing any service which requires internal access to the oscilloscope, adhere to the following precautions to avoid damaging internal modules and their components due to electrostatic discharge (ESD).

1. Minimize handling of static-sensitive modules.
2. Transport and store static-sensitive modules in their static protected containers. Label any package that contains static-sensitive modules.
3. Discharge the static voltage from your body by wearing a grounded antistatic wrist strap while handling these modules. Do service of static-sensitive modules only at a static-free work station.
4. Do not remove the oscilloscope cabinet unless you have met precaution number 3, above. Consider all internal modules static-sensitive.
5. Nothing capable of generating or holding a static charge should be allowed on the work station surface.
6. Handle circuit boards by the edges when possible.
7. Do not slide the modules over any surface.

8. Avoid handling modules in areas that have a floor or work-surface covering capable of generating a static charge.
9. Do not use high-velocity compressed air when cleaning dust from modules.

General Care

The cabinet helps keep dust out of the oscilloscope and it is a major component of its cooling system. It should normally be in place when operating the oscilloscope. The optional oscilloscope front cover protects the front panel and display from dust and damage. Install it when storing or transporting the oscilloscope.

Inspection and Cleaning Procedures

Inspect and clean the oscilloscope as often as operating conditions require. The collection of dirt on components inside can cause them to overheat and breakdown. (Dirt acts as an insulating blanket, preventing efficient heat dissipation.) Dirt also provides an electrical conduction path that could cause an oscilloscope failure, especially under high-humidity conditions.

CAUTION

Avoid the use of chemical cleaning agents that might damage the plastics used in this oscilloscope. Use only deionized water when cleaning the menu buttons or front-panel buttons. Use a 75% isopropyl alcohol solution as a cleaner and rinse with deionized water. Before using any other type of cleaner, consult your Tektronix Service Center or representative.

Avoid the use of high pressure compressed air when cleaning dust from the interior of this instrument. (High pressure air can cause ESD.) Instead, use low pressure compressed air (about 9 psi).

Inspection — Exterior

Using Table 8-1 as a guide, inspect the outside of the oscilloscope for damage, wear, and missing parts. You should thoroughly check oscilloscopes that appear to have been dropped or otherwise abused to verify correct operation and performance. Immediately repair defects that could cause personal injury or lead to further damage to the oscilloscope.

Table 8-1: External Inspection Check List

Item	Inspect For	Repair Action
Cabinet, front panel, and cover	Cracks, scratches, deformations, damaged hardware or gaskets.	defective module.
Front-panel knobs	Missing, damaged, or loose knobs.	Repair or replace missing or defective knobs.
Connectors	Broken shells, cracked insulation, and deformed contacts. Dirt in connectors.	defective modules. Clear or wash out dirt.
Carrying handle and cabinet feet	Correct operation.	defective module.
Accessories	Missing items or parts of items, bent pins, broken or frayed cables, and damaged connectors.	damaged or missing items, frayed cables, and defective modules.

Cleaning Procedure — Exterior

WARNING

To avoid injury or death, unplug the power cord from line voltage before cleaning the oscilloscope. To avoid getting moisture inside the oscilloscope during external cleaning, use only enough liquid to dampen the cloth or applicator.

1. Remove loose dust on the outside of the oscilloscope with a lint free cloth.
2. Remove remaining dirt with a lint free cloth dampened in a general purpose detergent-and-water solution. Do not use abrasive cleaners.
3. Clean the monitor screen with a lint-free cloth dampened with either isopropyl alcohol or, preferably, a gentle, general purpose detergent-and-water solution.

Inspection — Interior

To access the inside of the oscilloscope for inspection and cleaning, refer to the *Removal and Installation Procedures* in this section.

Inspect the internal portions of the oscilloscope for damage and wear, using Table 8-2 as a guide. You should repair defects immediately.

If you replace any electrical module, perform the adjustment procedures, beginning on page 7-1.

CAUTION

To prevent damage from electrical arcing, ensure that circuit boards and components are dry before applying power to the oscilloscope.

Table 8-2: Internal Inspection Check List

Item	Inspect For	Repair Action
Circuit boards	Loose, broken, or corroded solder connections. Burned circuit boards. Burned, broken, or cracked circuit-run plating.	
Resistors	Burned, cracked, broken, or blistered condition.	
Solder connections	Cold solder or rosin joints.	Resolder joint and clean with isopropyl alcohol.
Capacitors	Damaged or leaking cases. Corroded solder on leads or terminals.	
Wiring and cables	Loose plugs or connectors. Burned, broken, or frayed wiring.	Firmly seat connectors. Repair or replace modules with defective wires or cables.
Chassis	Dents and deformations	Straighten, repair, or replace chassis.

Cleaning Procedure — Interior



If, after doing steps 1 and 2, a module is clean upon inspection, skip the remaining steps.

1. Blow off dust with dry, low-pressure, deionized air (approximately 9 psi).
2. Remove any remaining dust with a lint free cloth dampened in isopropyl alcohol (75% solution) and rinse with warm deionized water. (A cotton-tipped applicator is useful for cleaning in narrow spaces and on circuit boards.)

NOTE

If steps 1 and 2 do not remove all the dust or dirt, the oscilloscope may be spray washed using a solution of 75% isopropyl alcohol by doing steps 3 through 7.

3. Gain access to the parts to be cleaned by removing easily accessible shields and panels (see *Removal and Replacement Procedures*).

4. Spray wash dirty parts with the isopropyl alcohol and wait 60 seconds for the majority of the alcohol to evaporate.
5. Use hot (120° F to 140° F or 48.9° C to 60° C) deionized water to thoroughly rinse them.
6. Dry all parts with low-pressure, deionized air.
7. Dry all components and assemblies in an oven or drying compartment using low-temperature (125° F to 150° F or 51.7° C to 65.5° C) circulating air.

Removal and Replacement

This section x contains procedures for removal and installation of all mechanical and electrical modules.

Preparation — Please Read

WARNING

To avoid injury or death, disconnect the power cord from the line voltage source before performing any procedure in this section.

General Instructions



READ THESE GENERAL INSTRUCTIONS BEFORE REMOVING A MODULE.

First locate the module you want to remove in the exploded views (Figures 11-1 and 11-2 on pages 11-6 and 11-11). Then read *Equipment Required* for a list of the tools needed to remove and install modules in this oscilloscope.

To remove an internal module, you need only remove the oscilloscope cabinet (page 8-13) and then perform the removal procedure for that module. The internal modules are independently removable.

Procedures will refer to “front,” “rear,” “top,” etc. of the oscilloscope; note from Figure 8-1 which sides are referenced.

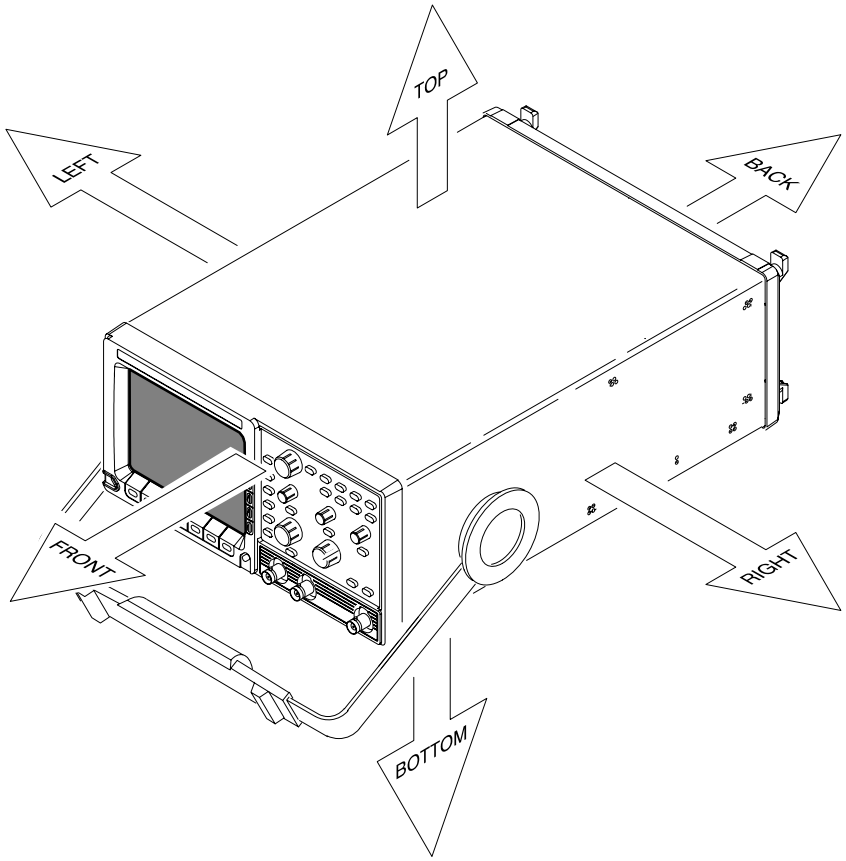


Figure 8-1: Oscilloscope Orientation

Equipment Required

The following tools are required to completely disassemble the oscilloscope into its modules. The tools required to remove an individual module are listed in the first step of its procedure.

Table 8-3: Tools Required for Module Removal

Item No.	Name	Description
1	Screwdriver handle	Accepts Torx®-driver bits.
2	T-15 Torx tip	Torx®-driver bit for T-15 size screw heads.
3	T-20 Torx tip	Torx®-driver bit for T-20 size screw heads. Used only for removal of the cabinet handle.
4	Flat-bladed screwdriver	Screwdriver for removing standard-head screws.

Table 8-3: Tools Required for Module Removal (Cont.)

Item No.	Name	Description
5	Nut driver, 5/16 inch	Used for removing earth ground cables.
6	Angle-tip tweezers	Used for knob and shaft removal.
7	Slip-Jaw Pliers	Used for removing the front feet from the cabinet.
8	Wooden Spudger	Used for front EMI gasket removal.
9	Front Cover	This optional accessory protects the front of the oscilloscope when positioned face down in the removal procedures.
10	Gloves, lint free, cloth	Used for removing the menu elastomer and menu button flex circuit.

Line Fuse and Line Cord

WARNING

To avoid injury or death, unplug the line cord from the line voltage power source before continuing.

1. Have handy a flat-bladed screwdriver (Item 4).
2. Set the oscilloscope so its bottom is down on the work surface and its rear is facing you.

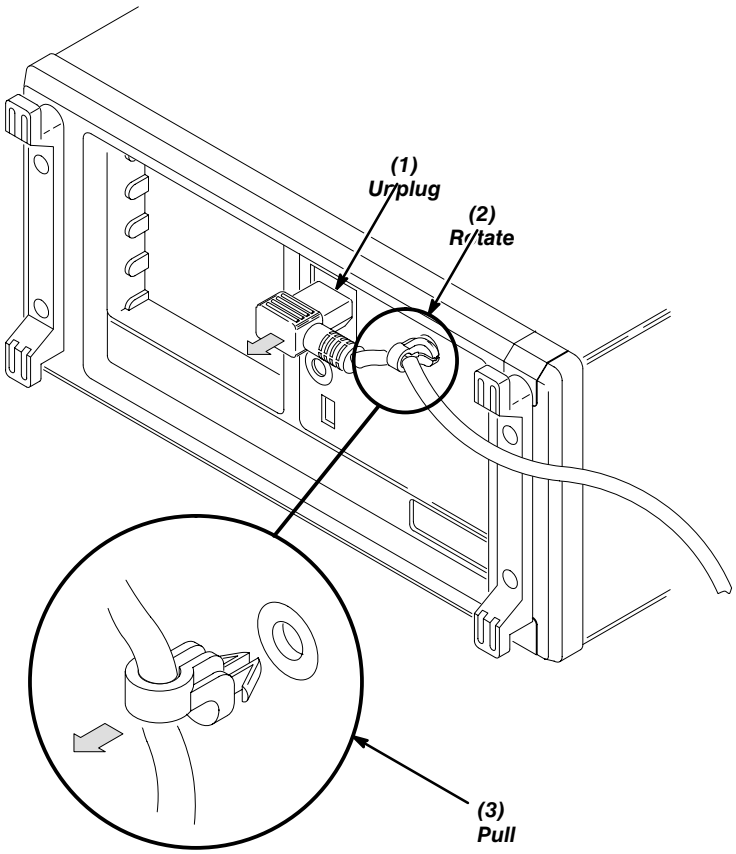


Figure 8-2: Line Cord Removal

3. Find the line cord on the rear cover. (See Figure 8-2.) Now, remove the line-cord retaining clamp by first unplugging the line cord from its receptacle.
4. Next, grasp both the line cord and the retaining clamp and rotate them 90 degrees counter-clockwise.
5. Pull the line cord and clamp away to complete the removal.
6. Find the fuse drawer beneath the line voltage plug on the rear panel. Now, pry open the drawer with a small flat-bladed screwdriver (Item 4), and remove the line fuse. (See Figure 8-3.)

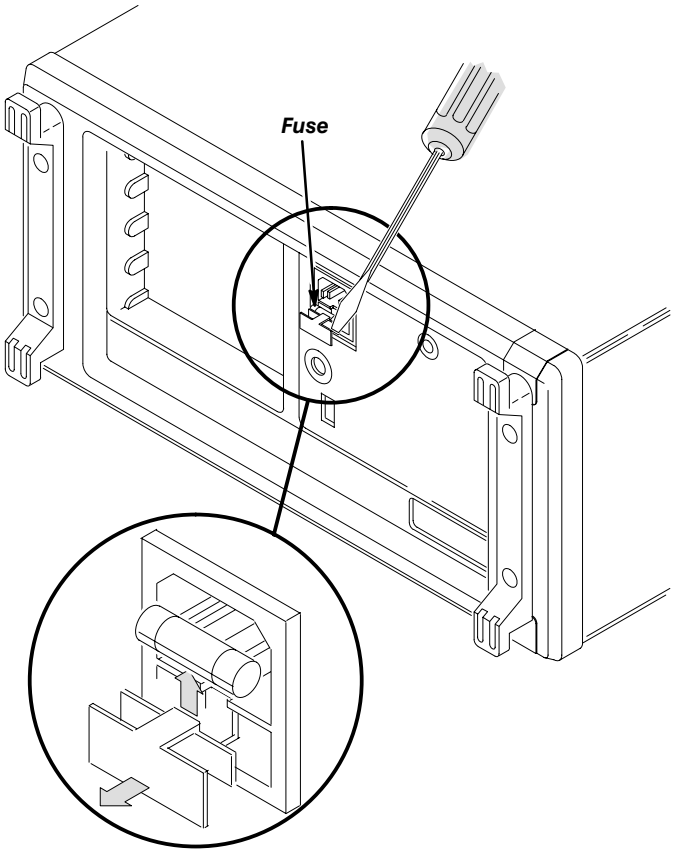


Figure 8-3: Line Fuse Removal

7. *Reinstallation:* Do in reverse steps 6 through 3 to reinstall the line fuse and then the line cord.

Front Panel Knobs and Shafts

1. Have handy a pair of angled-tip tweezers (Item 6).
2. Set the oscilloscope so its bottom is down on the work surface and its front is facing you.
3. Refer to Figure 8-4. Grasp any knob you wish to remove and pull it straight out from the front panel slightly to create some clearance between the base of the knob and the front panel.
4. Insert the tweezers between the knob and front panel and use them to remove the knob and its shaft.
5. Pull the shaft out of the knob to remove.

6. *Reinstallation:*

 a. To reinstall, align the inside of the knob to end of the shaft and push it in until it snaps.

 b. Insert the shaft of the assembled knob into its hole in the front panel assembly until it stops.

 c. Rotate the knob while lightly pushing inwards until the shaft slips into its receptacle. Push all the way in to seat the knob assembly.

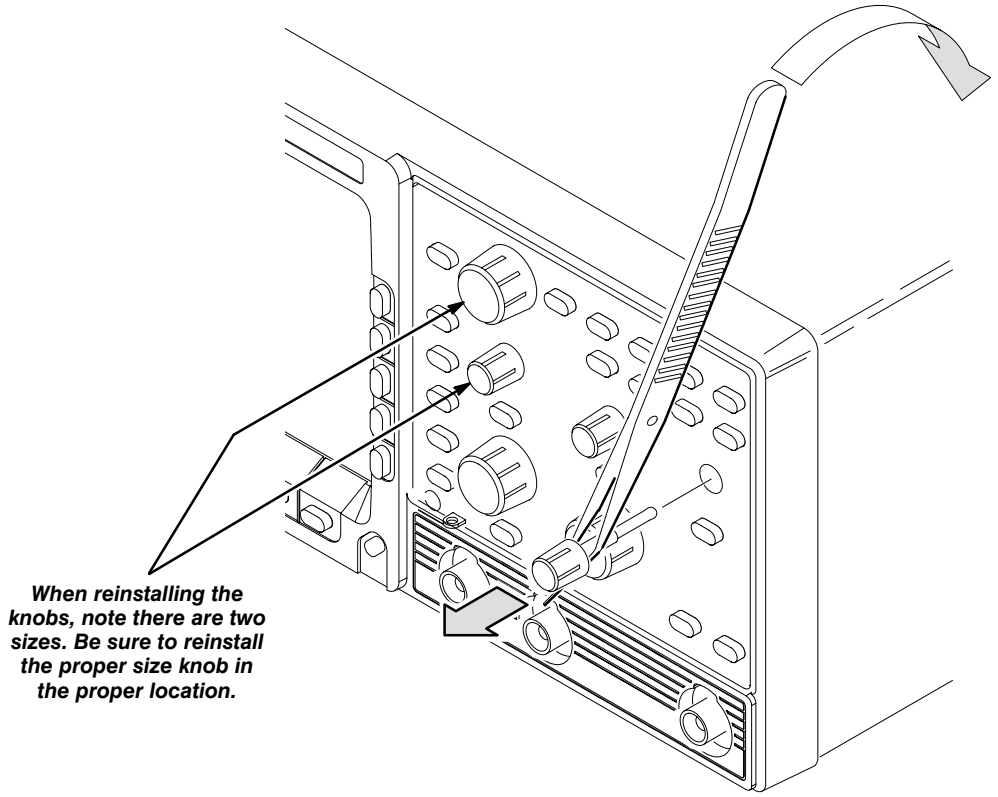


Figure 8-4: Knob and Shaft Removal

Rear Cover, Cabinet, and Cabinet Handle

1. Have handy a screwdriver with a size T-15 Torx® tip (Items 1 and 2).
2. Pull out on both of the hubs on the cabinet handle to unlock it for positioning. While holding the hubs unlocked, rotate the handle towards the bottom of the oscilloscope.
3. Set the oscilloscope so its face is down with its front cover on the work surface and its bottom facing you. Reference Figure 8-5 on page 8-14 as you do the following steps.
4. Remove the four T-15 Torx® screws securing the rear cover to the oscilloscope. Lift off the rear cover. If no other parts are being serviced, skip to the end (step 11) of this procedure.
5. Remove the single T-15 Torx® screw at the left side of the oscilloscope.
6. Lift the cabinet upwards to slide it off the oscilloscope.
7. If no other cabinet parts are being serviced, skip the rest of this procedure.
8. Working from the inside of the cabinet, remove the T-20 Torx® screw securing each handle hub to the cabinet.
9. Working from the outside of the cabinet, grasp the two handle hubs and pull them outward from the cabinet until they are out of the cabinet.
10. While holding the handle hubs pulled out, lift the handle away to remove.
11. *Reinstallation:*
 a. Do, in reverse order, steps 9 and 8 to reinstall the handle assembly.
 b. Do, in reverse order, steps 6 through 4 to reinstall the cabinet, while observing the following precautions:
 - Take care not to bind or snag the cabinet on internal cabling; redress cables as necessary.
 - When sliding the cabinet onto the oscilloscope, be sure that the front and rear ridges of the main chassis slide into the grooves at the rear of the cabinet and on the front trim.
 - Install the four screws at the rear panel before installing the single screw at the left side of the cabinet.

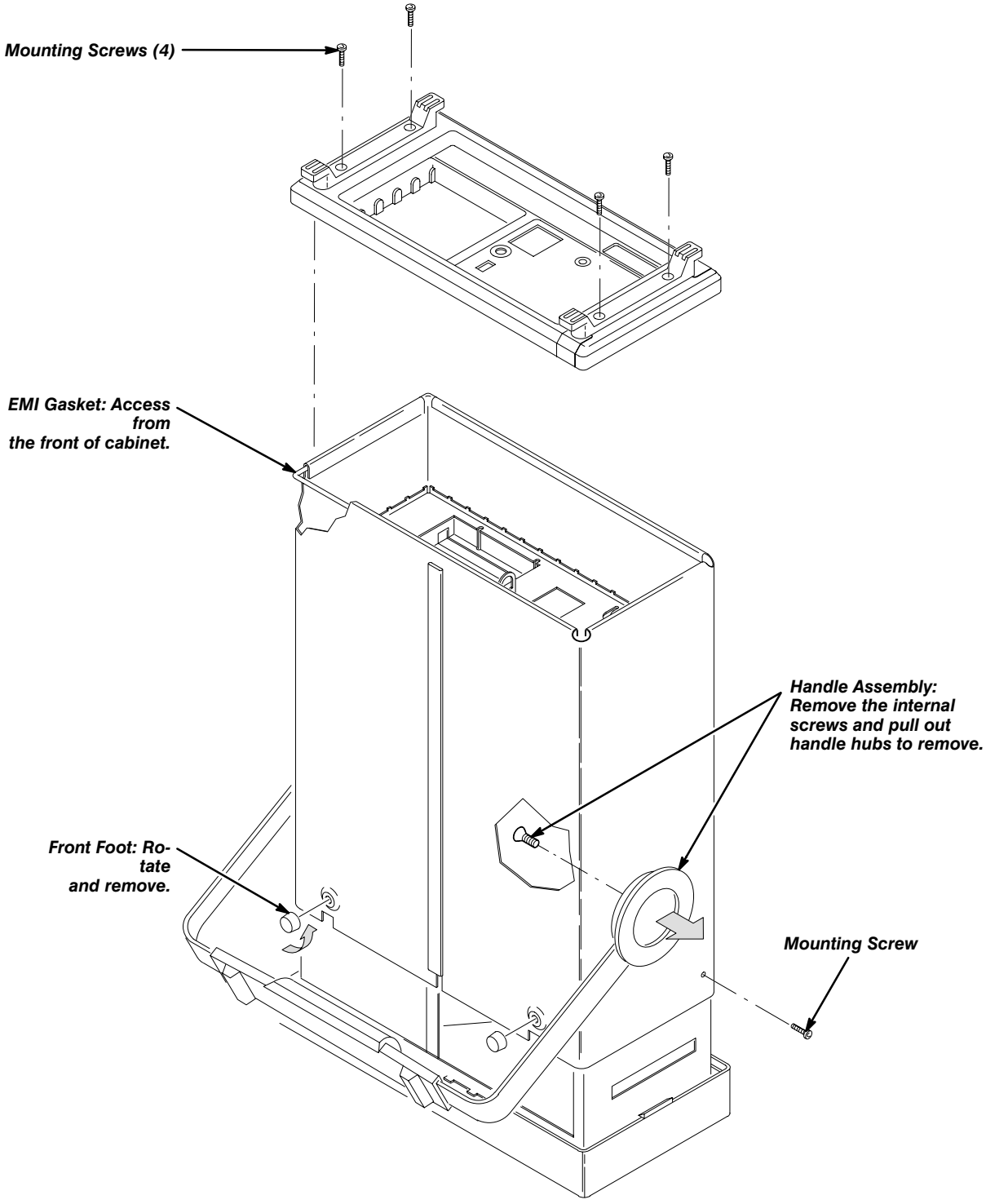


Figure 8-5: Rear Cover, Cabinet, and Cabinet Handle and Feet Removal

Trim Ring, Menu Elastomer, Menu Buttons, and Front EMI Gaskets

1. Have handy a wooden spudger (Item 8).
2. Set the oscilloscope so its rear is down on the work surface and its bottom is facing you.

STOP

DO NOT touch the carbon contact points on the menu elastomer installed in the trim ring. Also, do not touch the contacts on the menu button flex circuit exposed when you remove the trim ring. You should wear clean cloth gloves that are free of lint when handling the menu elastomer or when touching the menu button flex circuit mounted on the front chassis.

3. Grasp the trim ring by its top edge, pry it up, and lift it forward to snap it off the top front of the main chassis (see Figure 8-6).

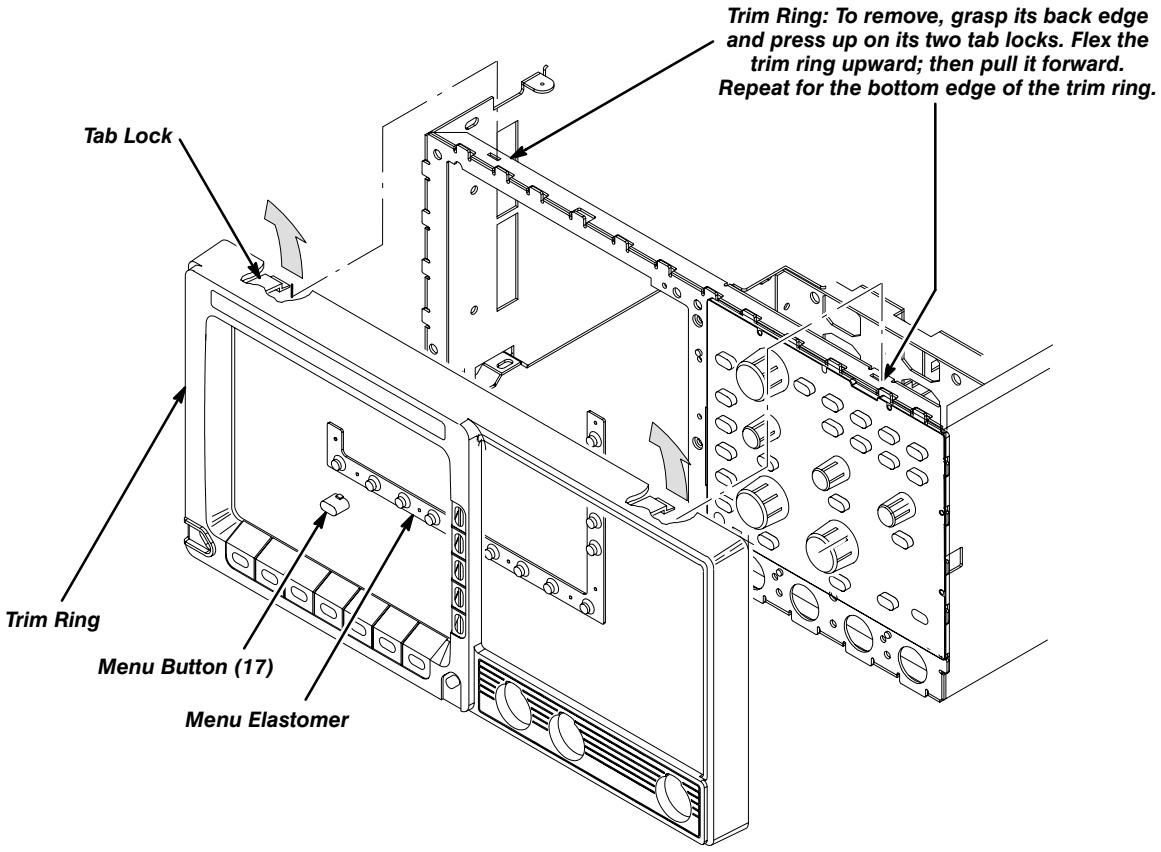


Figure 8-6: Trim Ring, Menu Elastomer, and Menu Buttons Removal

4. Repeat the process, prying on the bottom edge of the trim ring to complete its removal. Lay the trim ring on its face on the work surface.
5. If you are servicing the front EMI gaskets, discard the old ones.
6. If you are servicing the menu elastomer, lift it out of the trim ring.
7. If you are servicing the menu buttons, lift them out of the trim ring.

8. *Reinstallation:*

 a. Insert each button into its hole in the trim ring.

 b. Align the menu elastomer over the menu button holes in the trim ring and press it in to install. Avoid touching the carbon contact points on the elastomer when installing.

 c. Without installing the EMI gaskets, align the trim ring to the front of the chassis and push it on to seat. Be sure that both pairs of flex locks, one pair each at the inside top and bottom of the trim ring, snap over the edge of the chassis.

 d. Lay the oscilloscope so its front cover is on the work surface.

 e. Align an EMI gasket so it lies between any pair of adjacent flex locks along the groove between the cabinet.

 f. Using a wood spudger, push the EMI gasket until it is firmly seated at the bottom of the groove (see Figure 8-7). It should not overlap either flex lock.

 g. Repeat the process just described to install the remaining three gaskets.

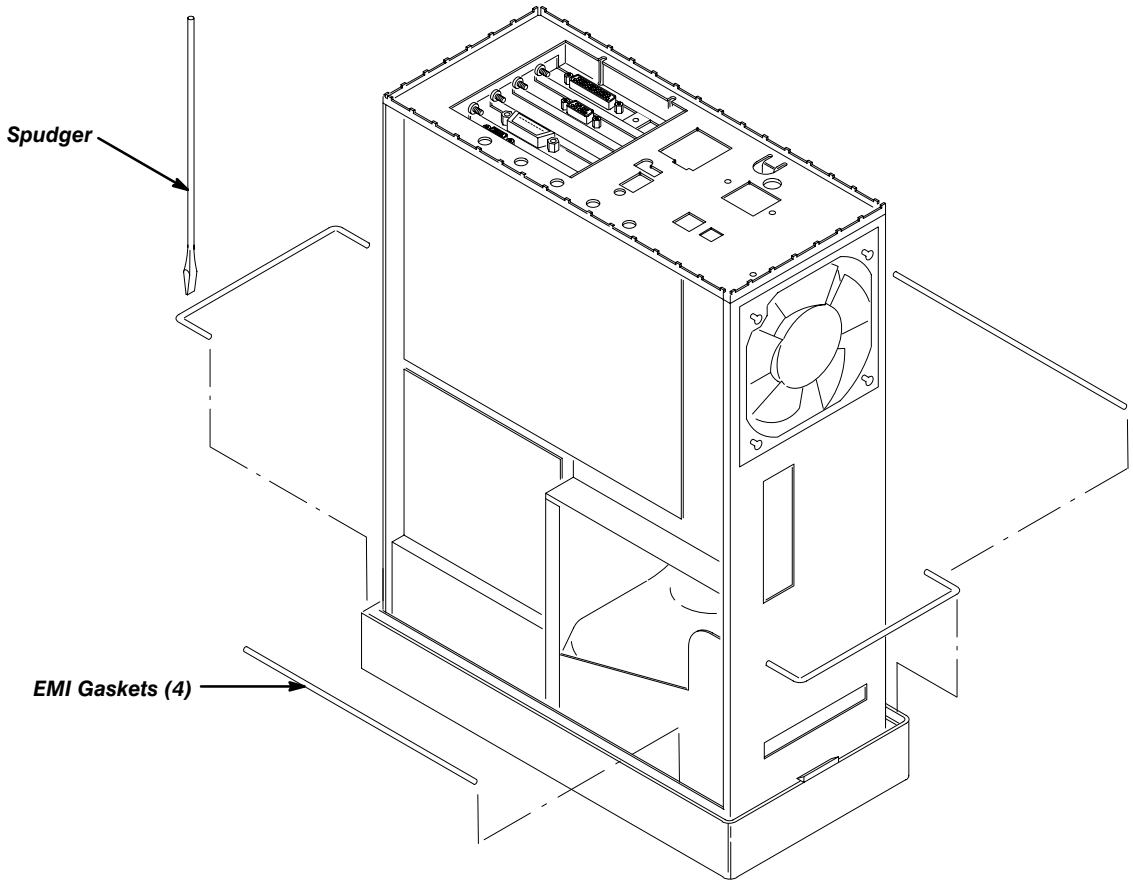


Figure 8-7: EMI Gasket Removal and Installation

Front Panel Assembly and Menu Flex Circuit

1. Perform the previous procedure to remove the trim ring.
2. Have handy a flat-bladed screwdriver (Item 4).
3. Set the oscilloscope so its bottom is down on the work surface and its front is facing you.
4. Insert a flat-bladed screwdriver into the slot at the front-right of the chassis (see Figure 8-8). Push inwards to release the snap lock at the right side.
5. Lift the front panel assembly out of the front of the main chassis until you can reach the interconnect cables connecting it to various other modules.
6. Unplug the main board and menu flex-circuit cables from their jacks on the front panel assembly.
7. Finally, lift the front panel assembly out of the front of the main chassis to complete the removal.

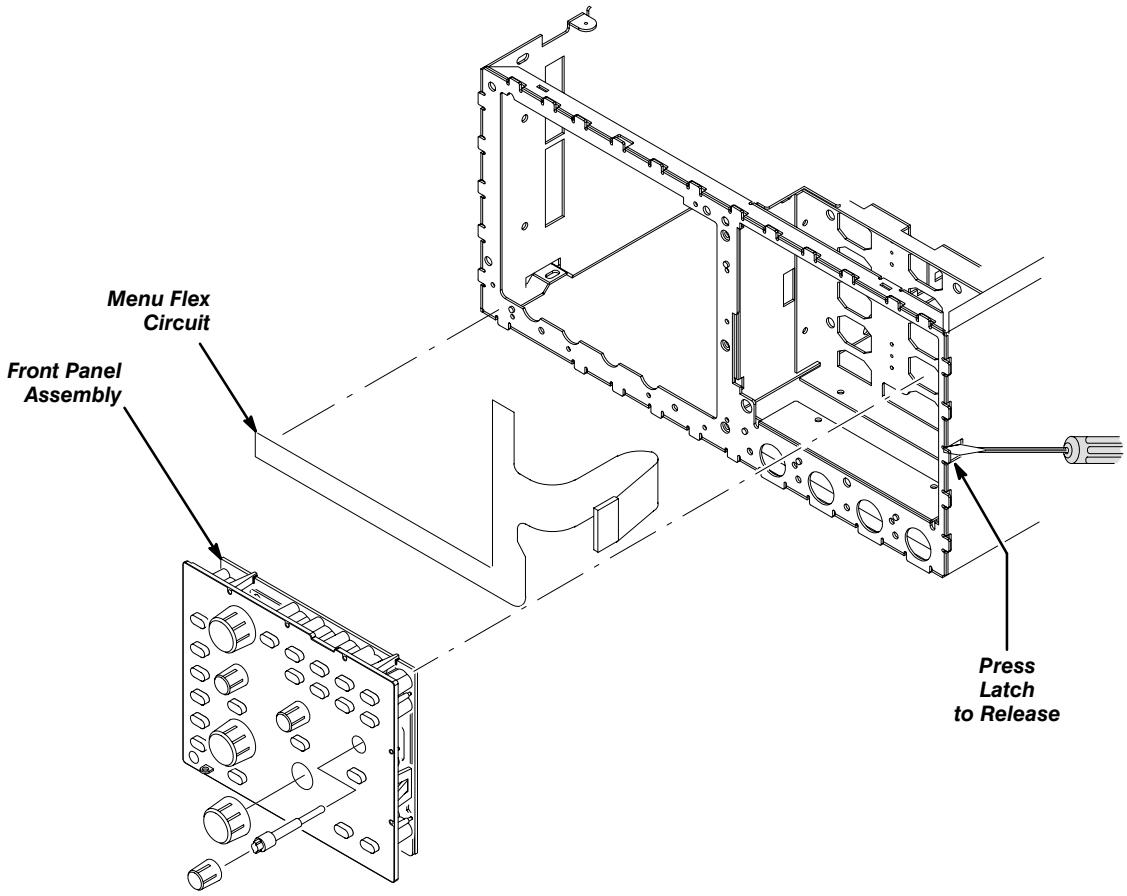


Figure 8-8: Front Panel Assembly and Menu Flex Circuit Removal

8. If you are removing the menu flex circuit, pull the circuit away from the front of the main chassis.

9. *Reinstallation:*

 a. If you are replacing the menu flex circuit, perform the following subparts:

 - Wipe the front of the chassis using isopropyl alcohol and a clean, lint-free cloth. Let it dry.
 - Find the score line in the adhesive backing and peel the backing off the menu flex circuit.
 - Carefully align the three holes on the menu flex circuit to the locator studs on the front of the main chassis. When the alignment is correct, press the flex circuit against the chassis so it adheres to the chassis.
 - Clean the surface of the menu flex circuit using isopropyl alcohol and a clean, lint-free cloth.

 b. Reconnect the main board and menu flex-circuit cables to the back of the front panel assembly.

 c. Carefully reinsert the front-panel assembly into the main chassis *left side first*.

Main Board Assembly

1. Have handy a screwdriver with a size T-15 Torx® tip (Items 1 and 2).
2. Remove the front trim ring as outlined on page 8-15.
3. Set the oscilloscope so its top side is down on the work surface and its front is facing you.
4. If present, unplug the option board cables.
5. Unplug the power supply cable *at the power supply*.
6. Unplug the monitor cable *at the monitor assembly and power supply*; carefully route the cable out through its access hole.
7. Unplug the front panel cable.
8. Using Figure 8-9 as a guide, remove the eight T-15 Torx® screws securing the main board assembly to the chassis.

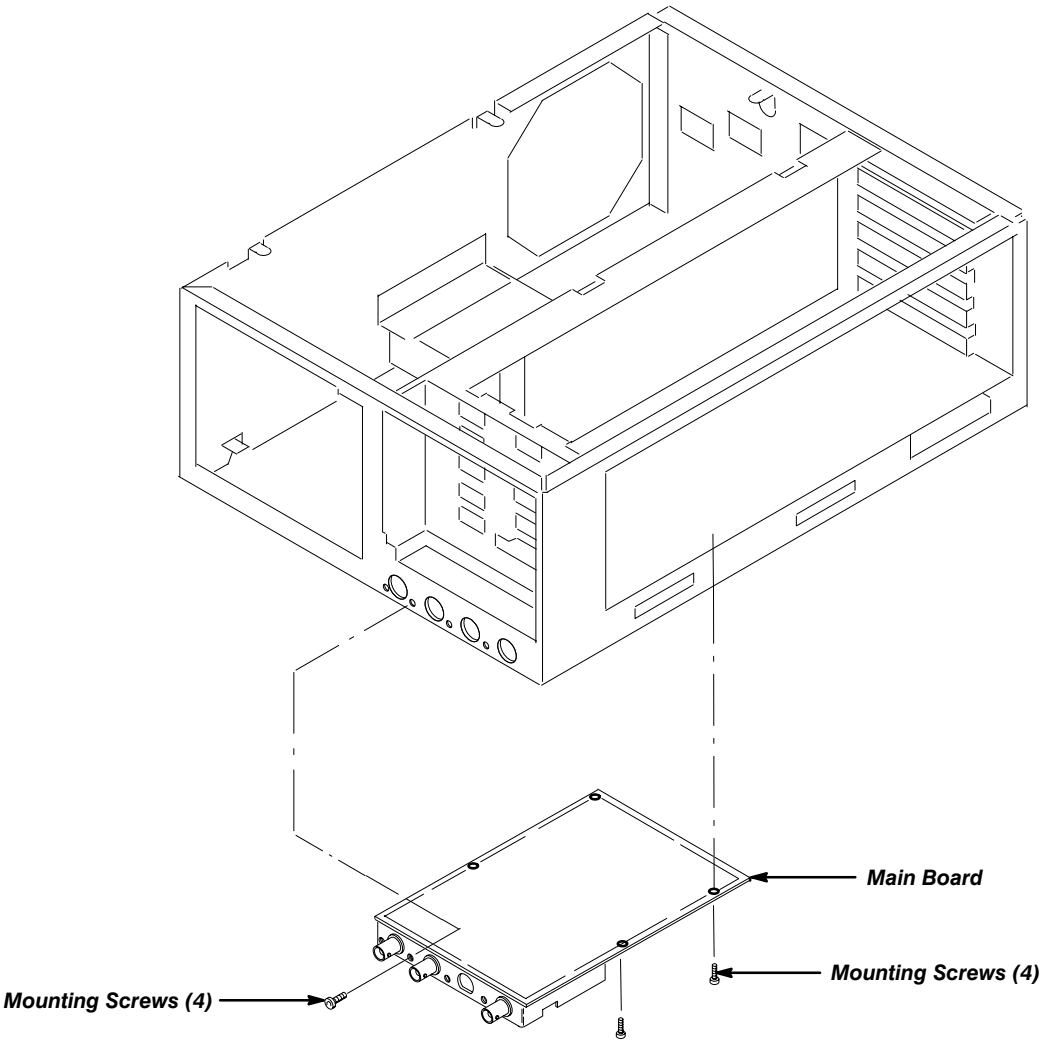


Figure 8-9: Main Board Removal

9. Lift the main board assembly away from the oscilloscope to complete its removal.
10. *Reinstallation:* Perform in reverse order steps 9 through 4, reversing the removal instructions in each substep to reinstall the assembly.

Monitor Assembly

1. Have handy a screwdriver with a size T-15 Torx® tip (Items 1 and 2).
2. Set the oscilloscope so its top is down on the work surface, with its front facing you.

WARNING

To avoid injury: *Use care when handling a monitor. If you break its display tube it may implode, scattering glass fragments with high velocity and possibly injuring you. Wear protective clothing, including safety glasses (preferably a full-face shield). Avoid striking the display tube with or against any object.*

To avoid damaging the monitor: *Store the monitor with its display tube face down in a protected location, placing it on a soft, nonabrasive surface to prevent scratching the face plate.*

3. Take the precautions outlined in the ***WARNING*** above. Refer to Figure 8-10 while doing the following steps.
4. Unplug the main board/power supply cable.
5. Remove the three T-15 Torx® screws securing the monitor assembly to the bottom of the main chassis. Rotate the oscilloscope so its bottom is down on the work surface.

WARNING

To avoid injury or death, do not unplug the anode from the monitor when removing or replacing the monitor module.

6. Remove the three T-15 Torx® screws securing the monitor assembly to the top of the chassis. (See Figure 8-10 to locate the screws.)
7. Push up on the left top tab lock on the trim ring and pull the left corner of the trim ring forward slightly.
8. Tilt the rear of the monitor assembly upward slightly. Slide the monitor assembly back in the main chassis until it stops (about 2 cm). Now lift it straight up out of the top of the main chassis to complete the removal.
9. While heeding the ***WARNING*** on monitor handling that immediately precedes step 3 of this monitor removal procedure, store the monitor assembly in a protected location. Place it face down on a soft, nonabrasive surface to prevent scratching the face plate.
10. *Reinstallation:* perform steps 8 through 5 in reverse order to reinstall the monitor assembly.

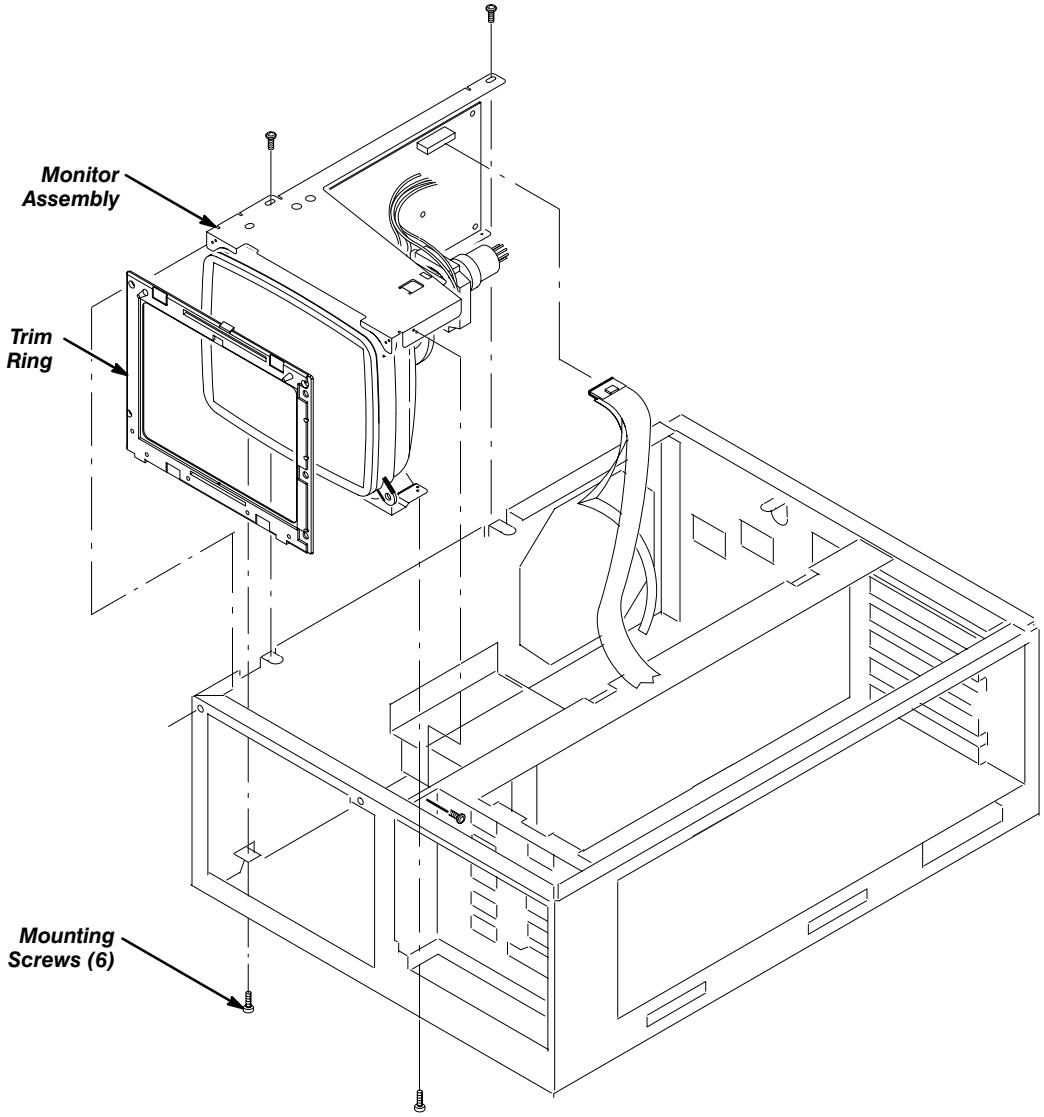


Figure 8-10: Monitor Assembly Removal

Power Supply Assembly

1. Have handy a screwdriver with a size T-15 Torx® tip (Items 1 and 2).
2. Set the oscilloscope so its right side is down on the work surface, with its bottom facing you.
3. Unplug the main board power cable.
4. Set the oscilloscope so its bottom is down on the work surface, with its front facing to the right.
5. If Option 14 is installed and its printer power cable is used on your instrument, unplug the printer power cable.
6. Unplug the monitor and fan power cables.
7. Remove the chassis ground connector by unbolting it from the main chassis.
8. Remove the two screws connecting the power supply assembly to the main chassis (see Figure 8-11).

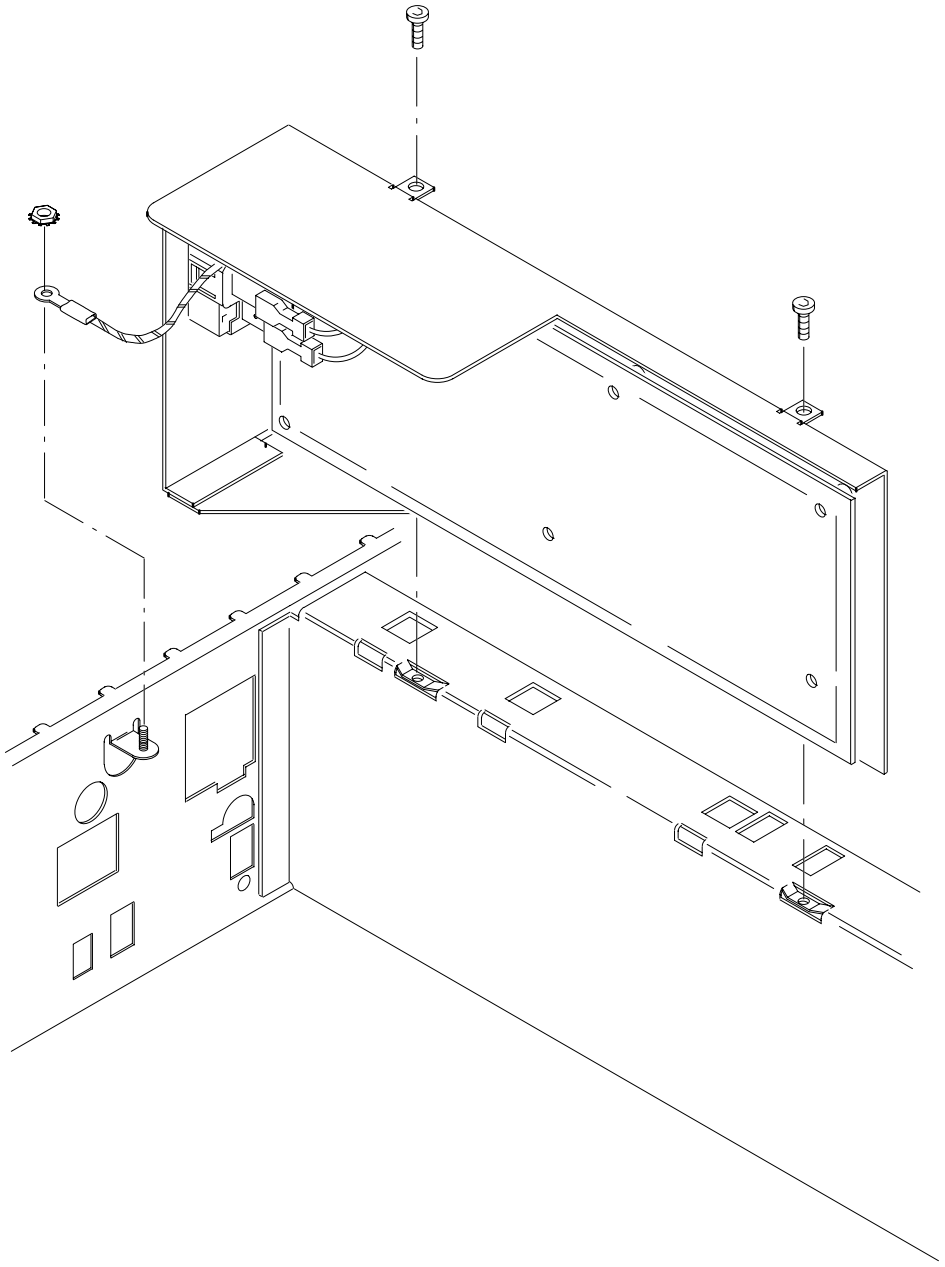


Figure 8-11: Low Voltage Power Supply Removal

9. Gently pull the power supply assembly up and out of the main chassis.
10. *Reinstallation:* Perform in reverse order steps 9 through 7, reversing the removal instructions in each substep to reinstall the assembly.

Option 14 Assembly

1. Have handy a screwdriver with a size T-15 Torx® tip (Items 1 and 2).
2. Set the oscilloscope so its top is down on the work surface, with its front facing towards you.
3. Disconnect the main board communications cable (J601) *at the main board*. Remove the cable from its cable clamp (see Figure 8-12).

NOTE

Early versions of this option did not use the video cable, power cable, or the screws at the rear of the chassis. If your option does not use these parts, skip steps 4, 5, and 7.

4. If used on your option, disconnect the video cable (J703) *at the main board*.
5. If used on your option, remove the two screws connecting the assembly to the chassis (see Figure 8-12) using a screwdriver with a size T-15 Torx® tip.
6. Set the oscilloscope so its bottom is down on the work surface, with its rear facing towards you.
7. If used on your option, disconnect power cable J4 from the power supply.
8. If your option has the video cable and printer power cable but they are not used on your option, remove the cables from their cable clamp.
9. Using a screwdriver with a size T-15 Torx® tip, remove the two screws on the left side of the assembly (see Figure 8-12).
10. Now remove the two screws on the rear panel that fasten the assembly to the chassis.
11. Pull the assembly towards the front of the instrument and up and out of the chassis. Carefully route the cables through their holes in the chassis.
12. *Reinstallation:* Perform steps 11 through 3 in reverse order.

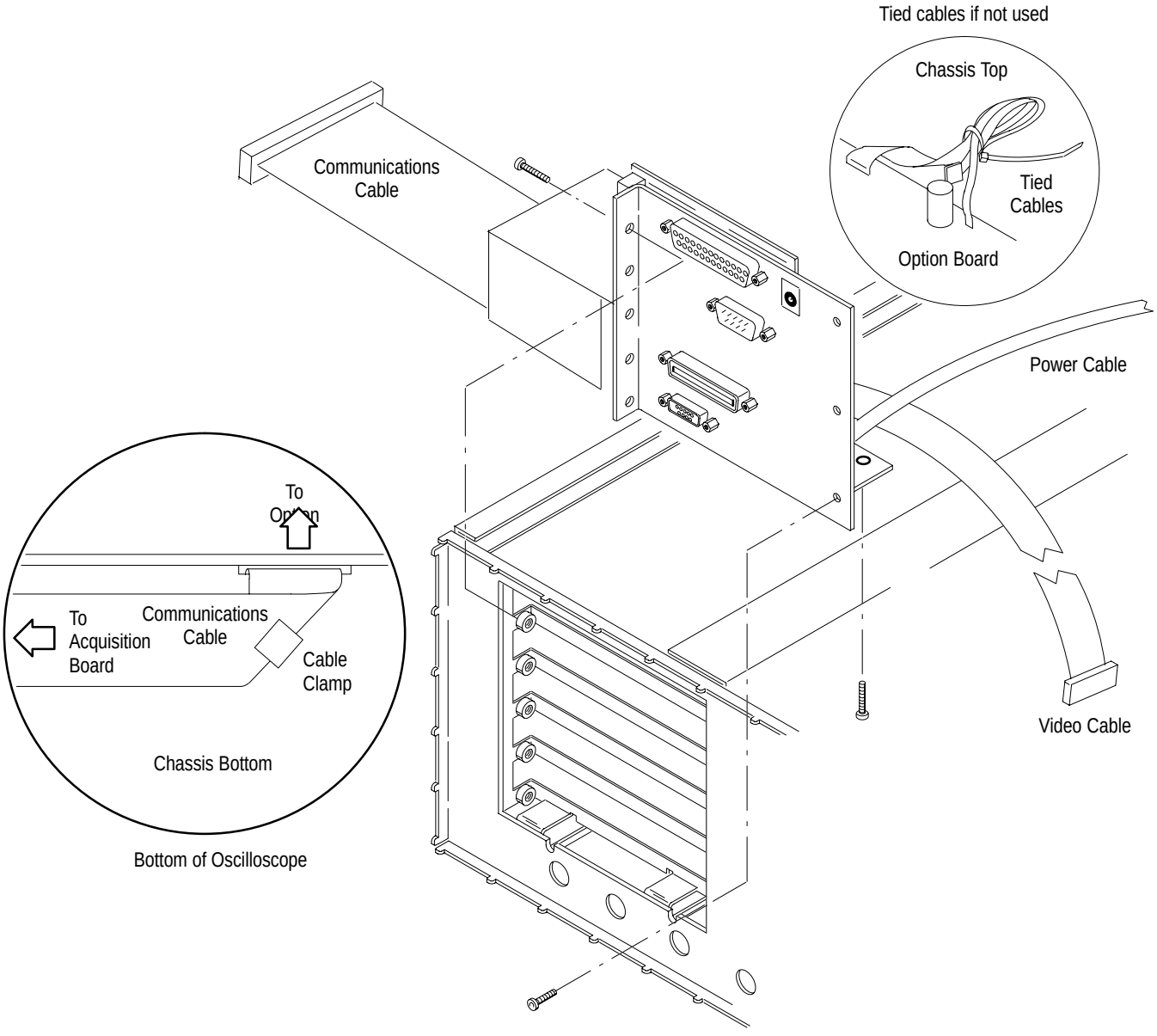


Figure 8-12: Option 14 Assembly Removal

Fan and Fan Mount

1. Set the oscilloscope so its bottom is down, with its rear facing you.
2. Unplug the *fan* power cable from J3 on the *Power Supply*.
3. Release the two flex locks securing the top of the fan to the fan mount, then lift the fan out from the top of the chassis (see Figure 8-13).

DO NOT proceed unless servicing a broken fan mount or removing that mount for cleaning.

4. Rotate the oscilloscope so the side that houses the fan *mount* is facing upwards.

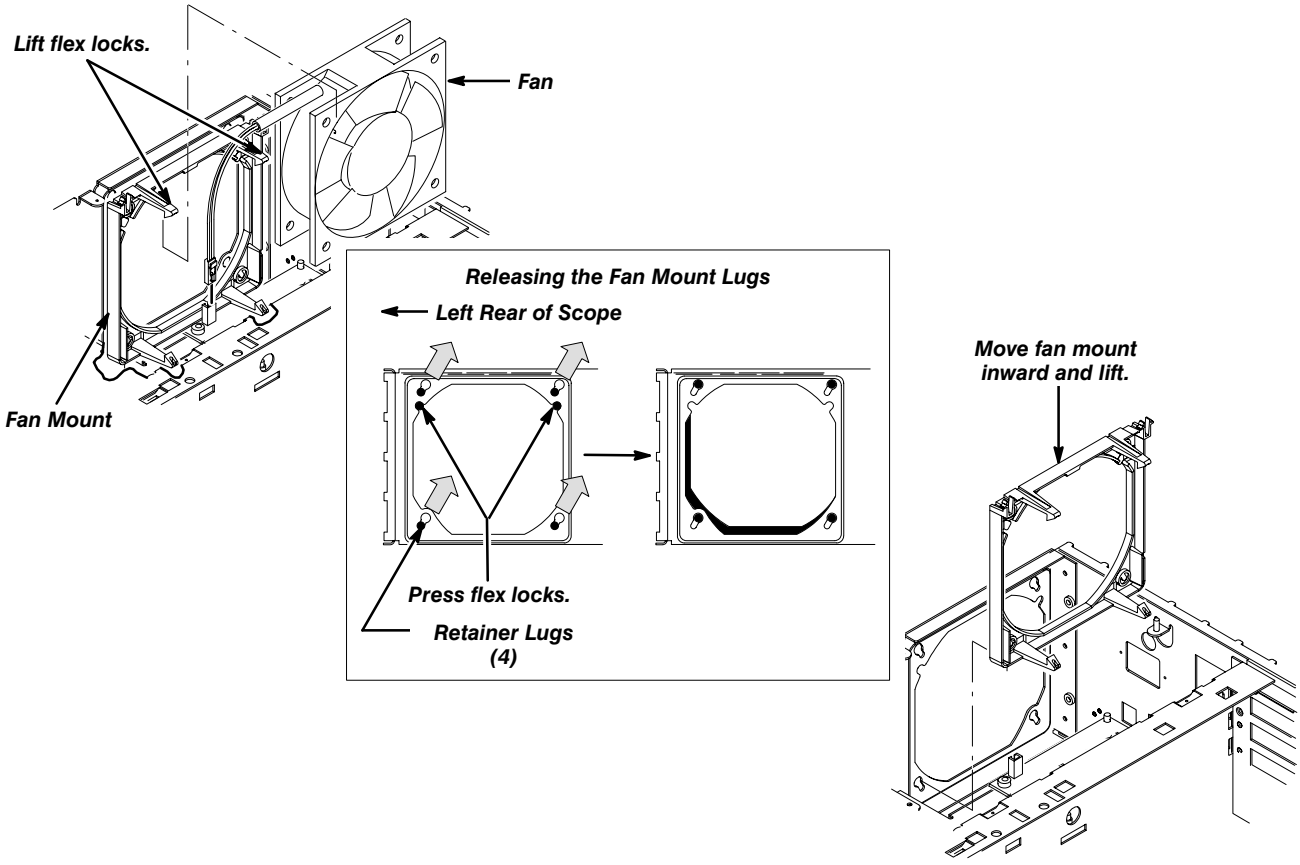


Figure 8-13: Fan and Fan Mount Removal

5. Depress the two flex locks to release them (see Figure 6-21).
6. While holding the flex locks released, slide the fan mount so its four retainer lugs slide from their small retainer holes in the chassis into their large release holes.
7. Move the fan mount inward so its retainer lugs are out of the large retainer holes and lift it out of the chassis to remove.
8. *Reinstallation:*
 a. Perform in reverse order steps 7 through 5 reversing the removal instructions in each substep to reinstall the fan mount. Be sure to seat the fan mount so its two flex locks snap to secure it on the chassis.
 b. Perform in reverse order steps 3 and 2 to reinstall the fan.

Troubleshooting

This section contains information and procedures designed to help you isolate faulty modules in the oscilloscope. If you need to replace a module, use the *Removal and Replacement* procedures immediately preceding this section.

Onboard Diagnostics

The onboard diagnostics focus on verifying, calibrating, and isolating faulty modules. Use the following procedure to activate the diagnostics.

1. Power up the oscilloscope and allow a 20 minute warm-up period.
2. Press the front panel button **UTILITY**.
3. Repeatedly press the main menu button **System** until **Diag** is highlighted in the pop-up menu. This calls up the diagnostics menu, shown in Figure 8-14.

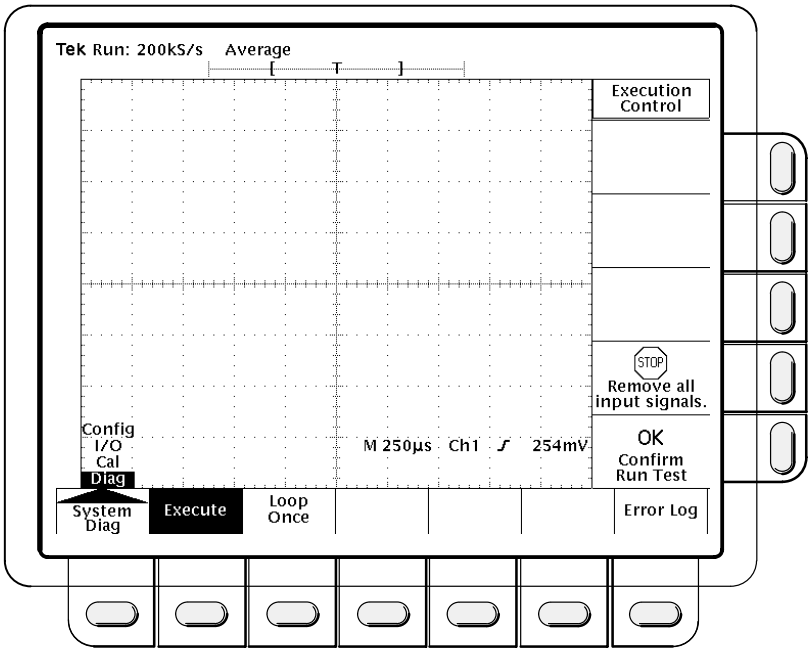


Figure 8-14: The Diagnostics Menu

4. Press the main menu button **Loop**. Select one of the following options from the side menu.
 - Press **Once** to run the tests once.
 - Press **Always** to run the tests continuously until you cycle the power.

- Press **Until Fail** to run the tests continuously until the instrument fails a test or until you cycle the power.

5. Press the main menu button **Execute**; press the side menu button **Ok Confirm Run Test**.
6. Wait. The diagnostics will take about two minutes to complete. Then the oscilloscope displays pass/fail results for each system.
7. If the onboard diagnostics indicate a failure, reenter the diagnostics menu and press the main menu button **Error Log**.

NOTE

The RS232 Line Snapshot and RS232 Errors are reset at each power-on. For more RS-232 information, see Making Hardcopies *on page 3-43 and the* TDS 310, TDS 320, & TDS 350 Programmer Manual*.*

8. Press the side menu button **Display Log** to display the diagnostics error log. The error log contains summary data gathered over the life of the oscilloscope and descriptions of the last 200 errors encountered (see Figure 8-15). The last error in the list is the most recent and/or most important; record this information and continue on to the *Troubleshooting Procedure* in the next section to verify the failure and pinpoint the faulty module.

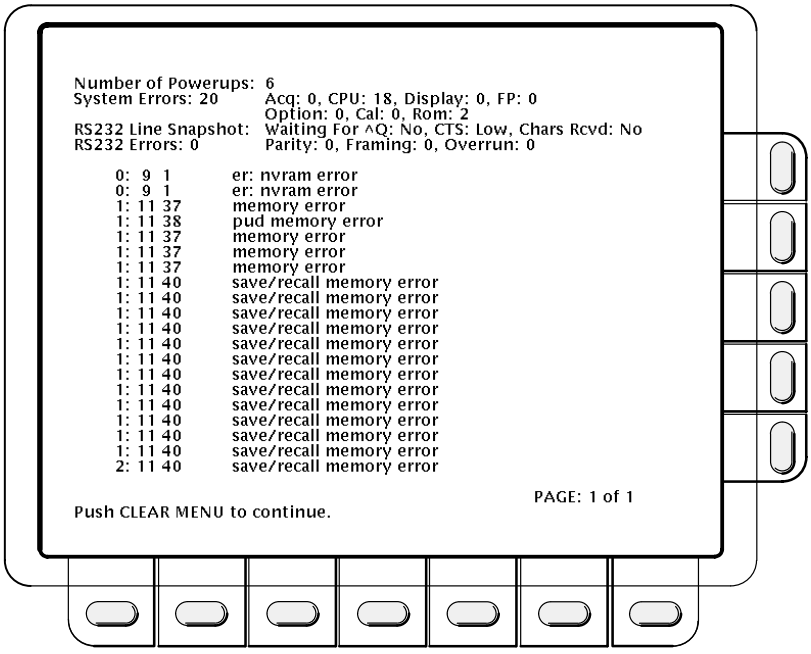


Figure 8-15: The Error Log

Enabling Calibration Menus

The Voltage, Timing, and External Trigger calibration menus are disabled at the factory. To enable the calibration menus, perform the following steps.

NOTE

Early versions of the TDS 320 did not contain a cal jumper and did not disable the calibration menus. Do not use this procedure on those instruments.

1. Remove the Line Cord as described on page 8-9.
2. Remove the Rear Cover and Cabinet as described on page 8-13.
3. Set the oscilloscope so its top side is down on the work surface and its front is facing you.
4. Remove cal jumper J609 from the main board (see Figure 8-16). Save the jumper. After calibration and to protect the calibration settings, reinstall the jumper.
5. *Reinstallation:* Perform in reverse order steps 1 and 2, reversing the removal instructions in each substep.

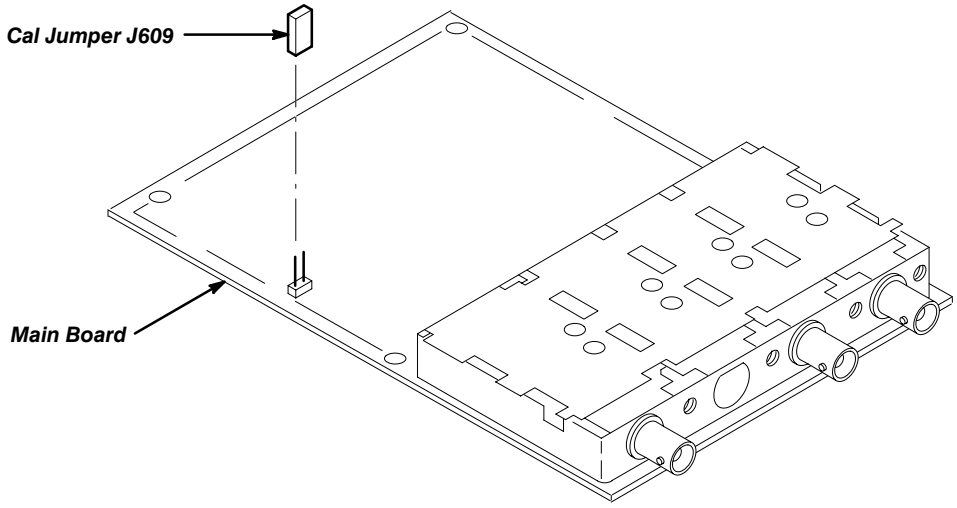


Figure 8-16: Main Board Cal Jumper

Troubleshooting Procedure

Figures 8-17 through 8-26 are flowcharts of the troubleshooting procedure. Use them to verify module failures indicated by the onboard diagnostics, or use them to troubleshoot an instrument failure not connected with the diagnostics. Begin with Figure 8-17.

NOTE

Before performing the troubleshooting procedure, remove the instrument cabinet (see page 8-13).

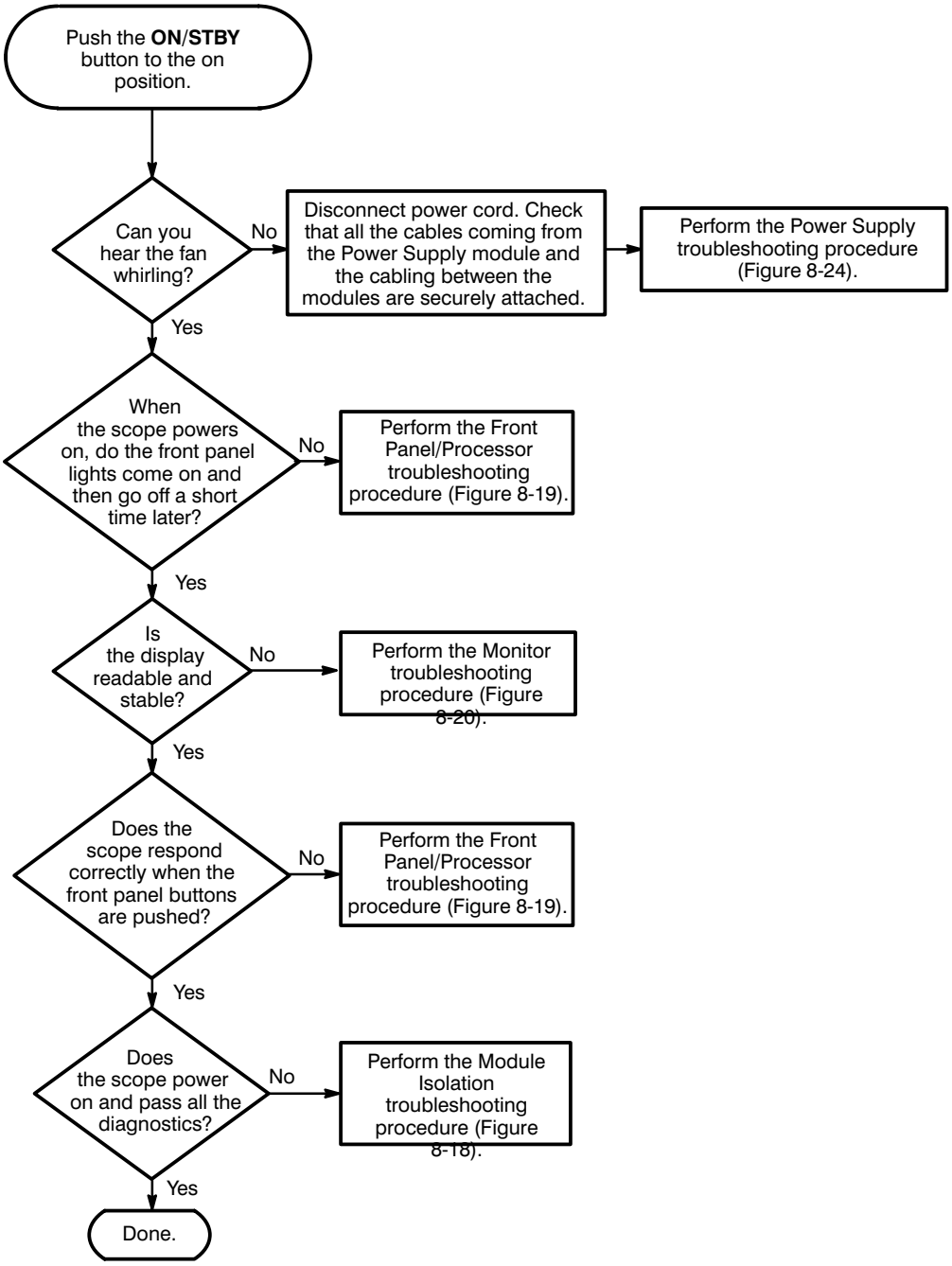


Figure 8-17: Primary Troubleshooting Procedure

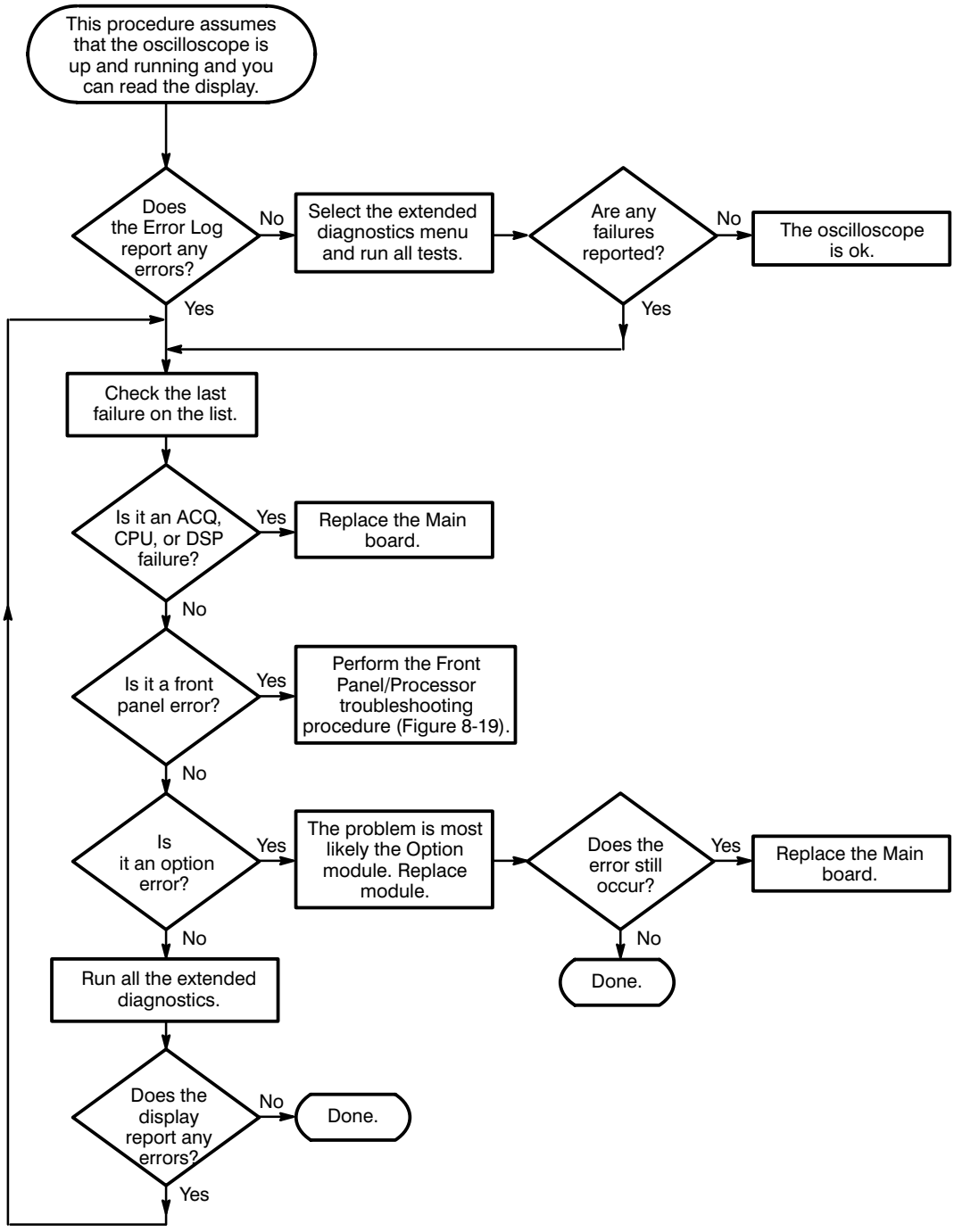


Figure 8-18: Module Isolation Troubleshooting Procedure

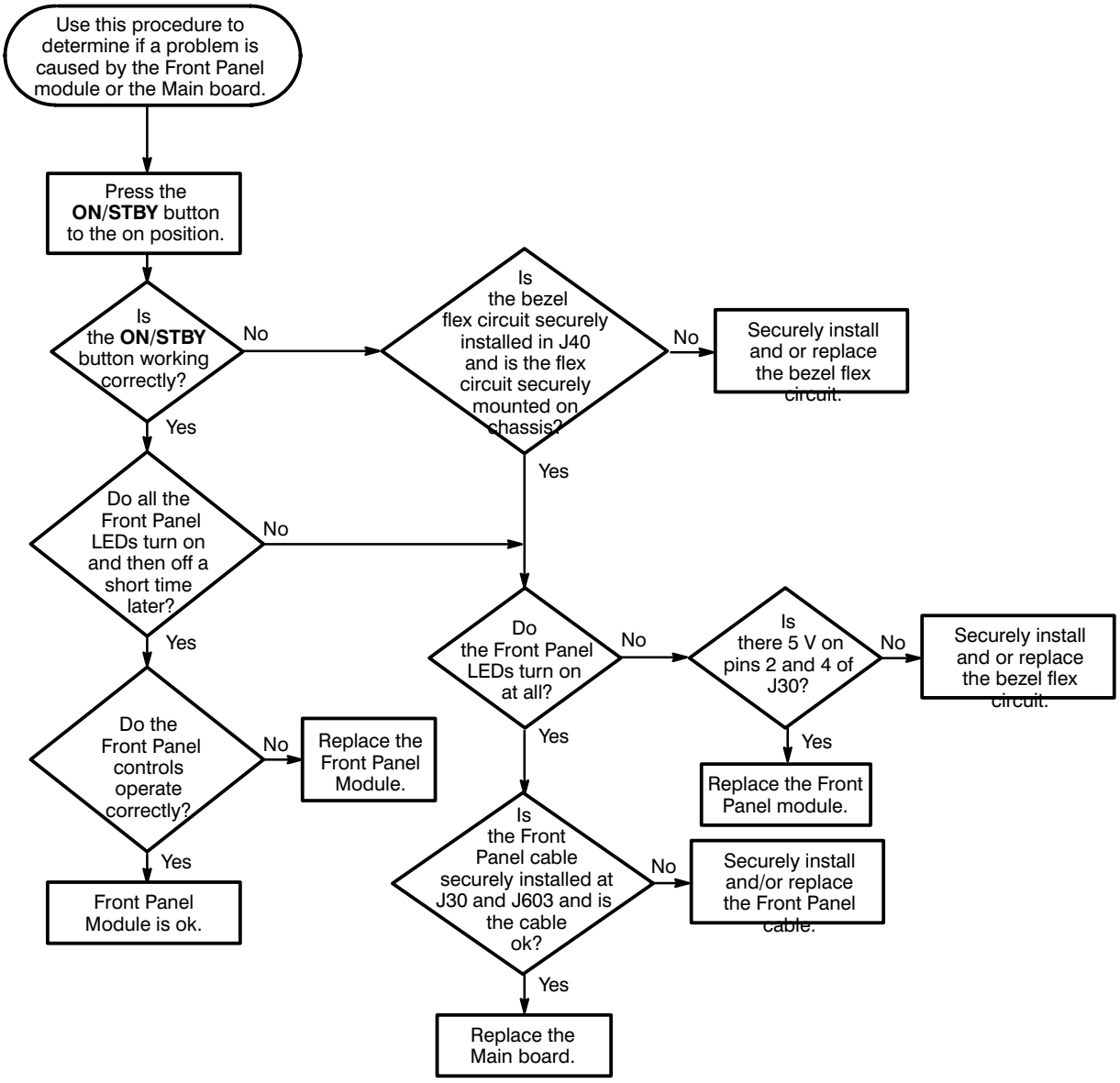


Figure 8-19: Front Panel/Processor Troubleshooting Procedure

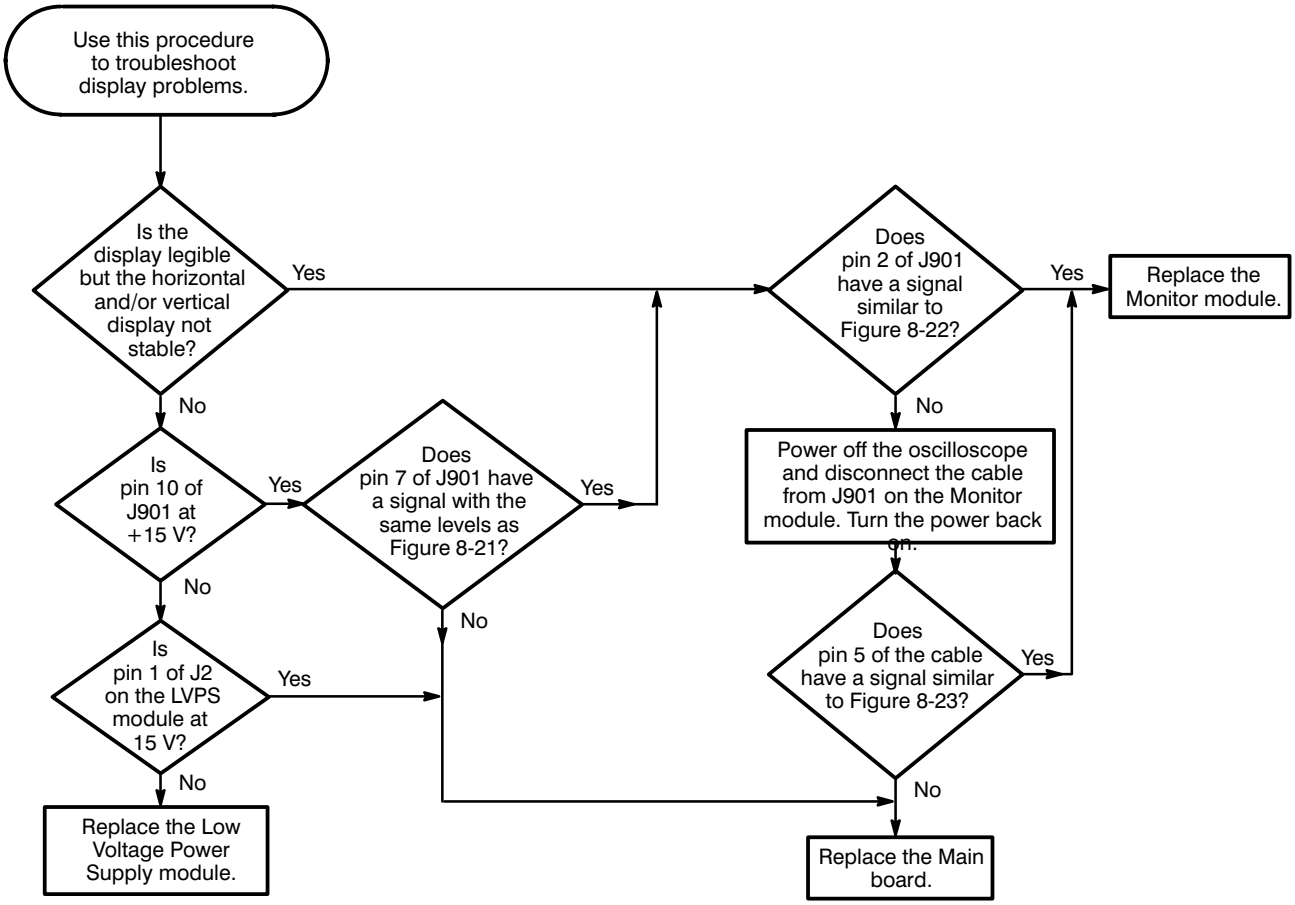


Figure 8-20: Monitor Troubleshooting Procedure

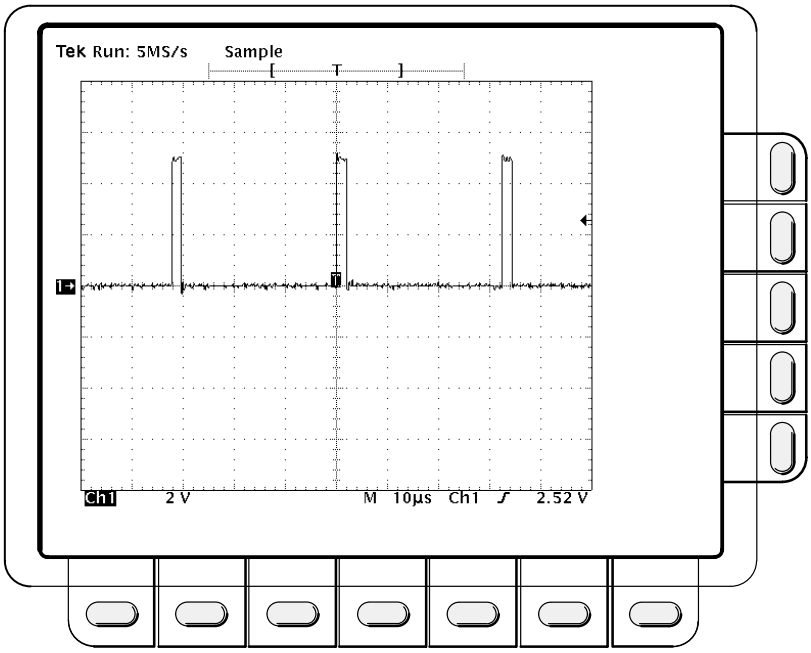


Figure 8-21: J901 Pin 7 Signal

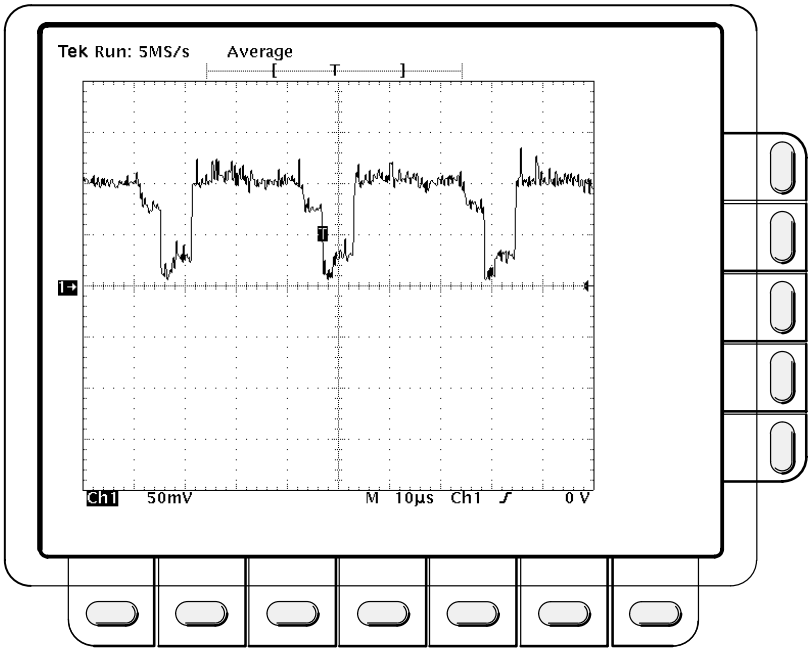


Figure 8-22: J901 Pin 2 Signal

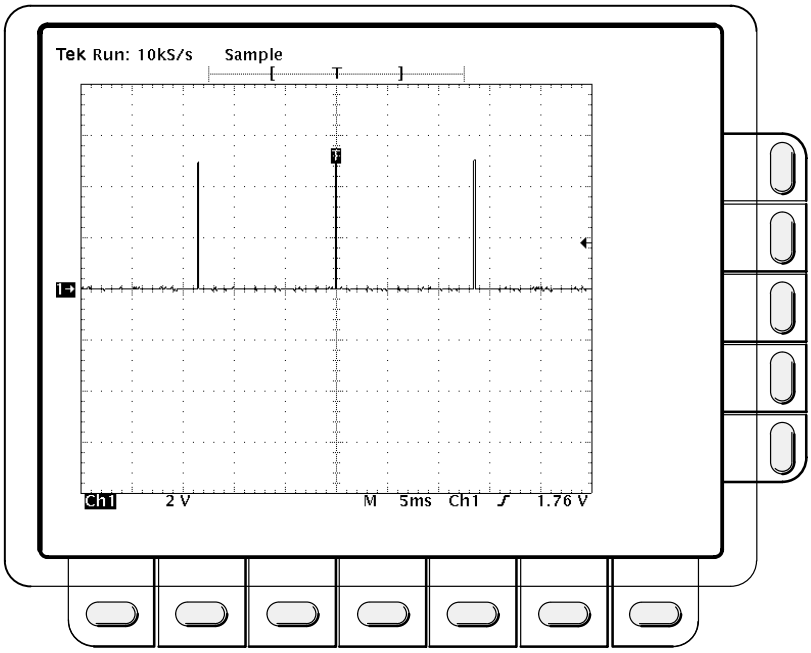


Figure 8-23: J901 Pin 5 Signal

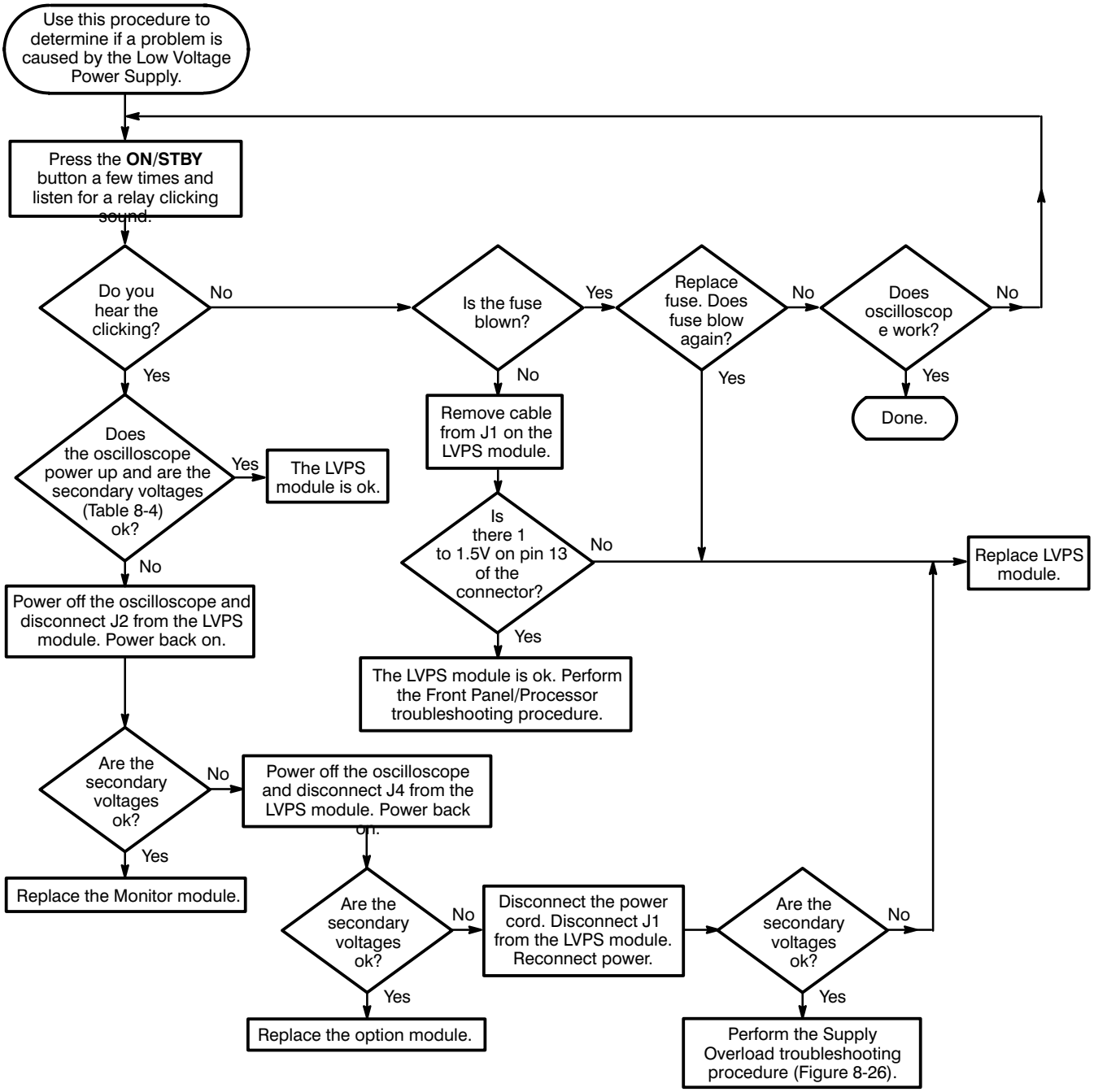


Figure 8-24: Power Supply Troubleshooting Procedure

Table 8-4: Power Supply Secondary Voltages

Location (See Figure 8-25)	Minimum	Maximum
J1 pin 2	+8.38 V	+8.82 V
J1 pins 5 and 6	+4.87 V	+5.13 V
J1 pin 8	+4.87 V	+5.13 V
J1 pin 10	−8.38 V	−8.82 V
J1 pin 11	−4.87 V	−5.13 V
J1 pin 13, ON	+0.991 V	+1.137 V
J1 pin 13, STBY	+1.272 V	+1.406 V
J2 pin 1	+13.80 V	+15.75 V
J3 pin 1, fan connected	+10.20 V	+13.80 V
J3 pin 1, fan disconnected	+13.80 V	+15.75 V
J4 pin 1	+13.80 V	+15.75 V

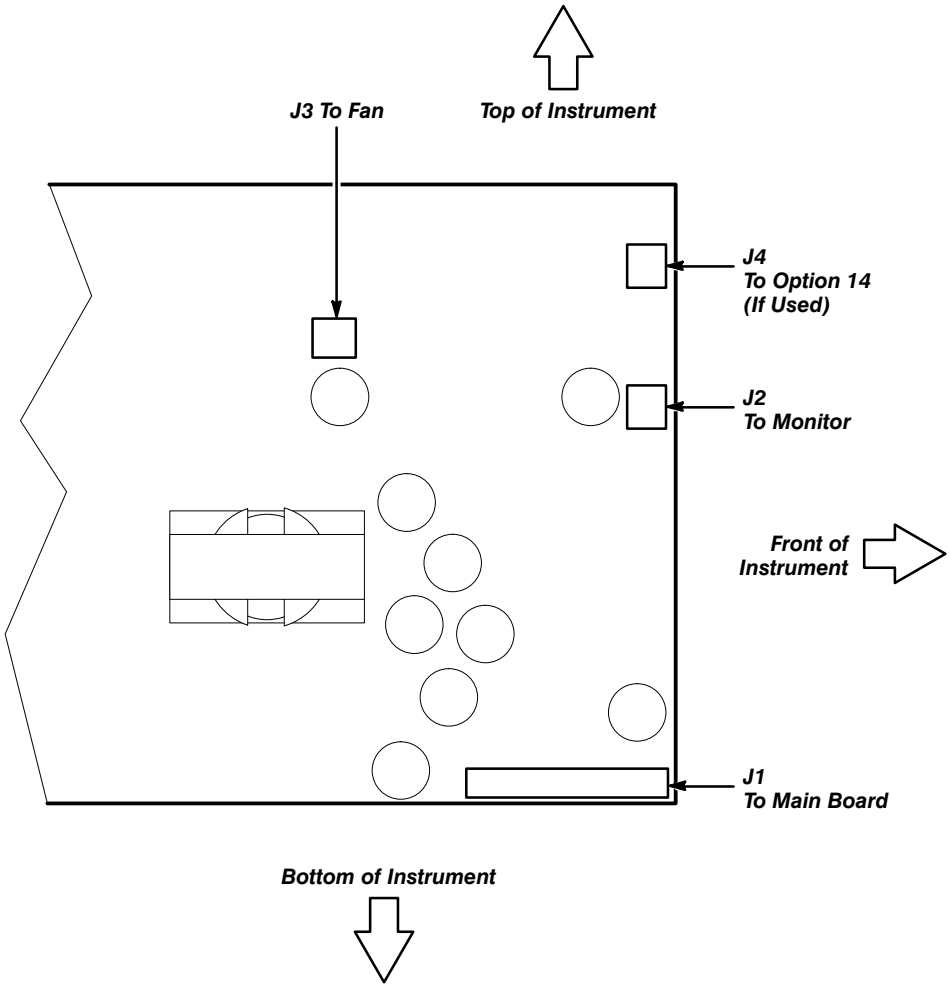


Figure 8-25: Power Supply Connector Locations

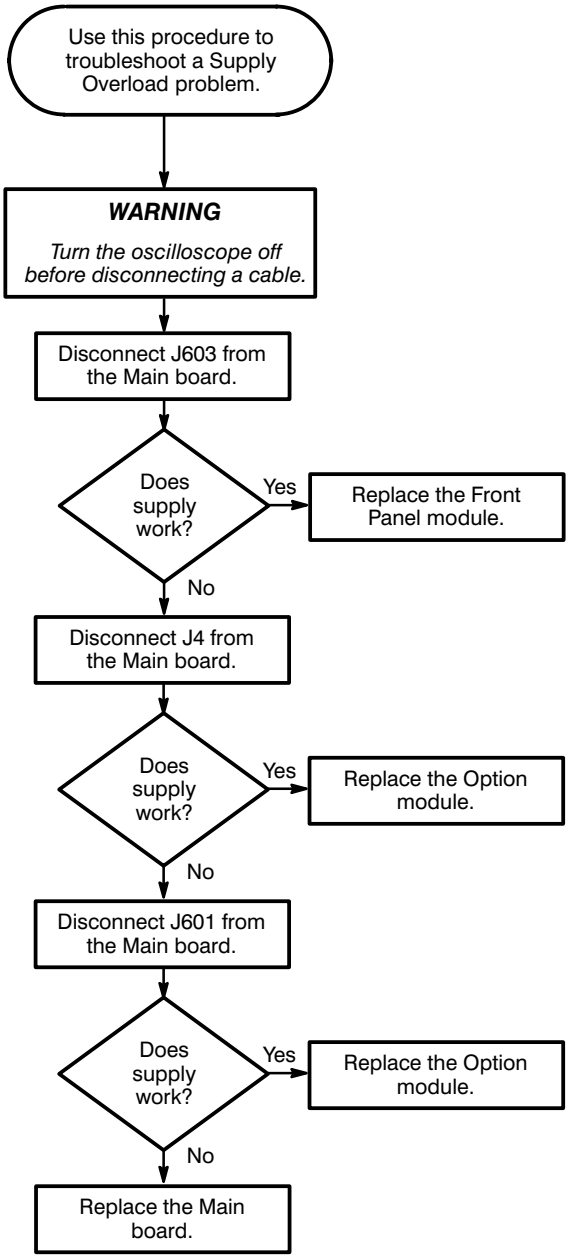


Figure 8-26: Supply Overload Troubleshooting Procedure

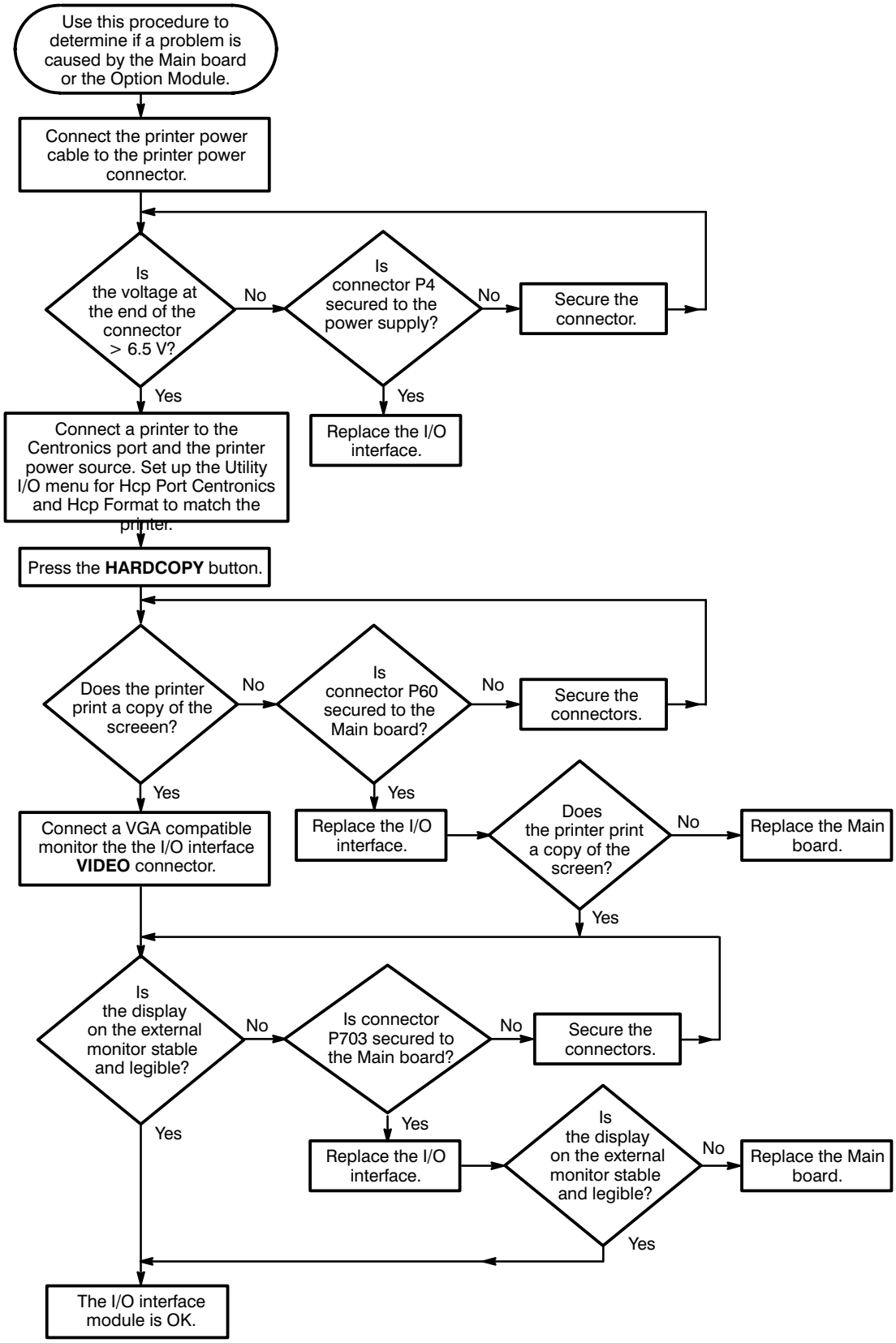


Figure 8-27: I/O Interfaces Option Troubleshooting Procedure

Repackaging Instructions

If you ship the oscilloscope, pack it in the original shipping carton and packing material. If the original packing material is not available, package the instrument as follows:

1. Obtain a corrugated cardboard shipping carton with inside dimensions at least 15 cm (6 in) taller, wider, and deeper than the oscilloscope. The shipping carton must be constructed of cardboard with 170 kg (375 pound) test strength.
2. If you are shipping the oscilloscope to a Tektronix field office for repair, attach a tag to the oscilloscope showing the instrument owner and address, the name of the person to contact about the instrument, the instrument type, and the serial number.
3. Wrap the oscilloscope with polyethylene sheeting or equivalent material to protect the finish.
4. Cushion the oscilloscope in the shipping carton by tightly packing dunnage or urethane foam on all sides between the carton and the oscilloscope. Allow 7.5 cm (3 in) on all sides, top, and bottom.
5. Seal the shipping carton with shipping tape or an industrial stapler.

Electrical Parts List

Replaceable Module Assemblies

The modules that make up the TDS 310, TDS 320, and TDS 350 are listed in Section 11, *Replaceable Mechanical Parts*, beginning on page 11-1.

Diagrams

Diagrams

The TDS 310, TDS 320, and TDS 350 block/interconnect diagram is in Figure 5-1 on page 5-2.

Mechanical Parts List

Replaceable Parts

This section contains a list of the modules that are replaceable for the TDS 310, TDS 320, and TDS 350. Use this list to identify and order replacement parts.

Parts Ordering Information

Replacement parts are available from or through your local Tektronix, Inc. service center or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available and to give you the benefit of the latest circuit improvements. Therefore, when ordering parts, it is important to include the following information in your order:

- Part number
- Instrument type or model number
- Instrument serial number
- Instrument modification number, if applicable

If a part you order has been replaced with a different or improved part, your local Tektronix service center or representative will contact you concerning any change in the part number.

Change information, if any, is located at the rear of this manual.

Module Replacement

TDS 300 Series oscilloscopes are serviced by module replacement. There are three options you should consider:

- **Module Exchange.** In some cases you may exchange your module for a remanufactured module. These modules cost significantly less than new modules and meet the same factory specifications. For more information about the module exchange program, call 1-800-TEKWIDE, ext. 6630.
- **Module Repair.** You may ship your module to us for repair, after which we will return it to you.
- **New Modules.** You may purchase new replacement modules in the same way as other replacement parts.

Using the Replaceable Parts List

The tabular information in the Replaceable Parts List is arranged for quick retrieval. Understanding the structure and features of the list will help you find the all the information you need for ordering replacement parts.

Item Names

In the Replaceable Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, U.S. Federal Cataloging Handbook H6−1 can be used where possible.

Abbreviations

Abbreviations conform to American National Standards Institute (ANSI) standard Y1.1.

CROSS INDEX – MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
S3109	FELLER	72 VERONICA AVE UNIT 4	SUMMERSET NJ 08873
S4246	JAPAN SERVO CO LTD	7 KANDA MITOSHIRO–CHO CHIYODA–KU	TOKYO JAPAN
TK0435	LEWIS SCREW CO	4300 S RACINE AVE	CHICAGO IL 60609–3320
TK0946	SAN–O INDUSTRIAL CORP	170 WILBUR PL	BAHEMIA LONG ISLAND NY 11716
TK1163	POLYCAST INC	9898 SW TIGARD ST	TIGARD OR 97223
TK1499	AMLAN INC	97 THORNWOOD RD	STAMFORD CT 06903–2617
TK1908	PLASTIC MOLDED PRODUCTS	4336 SO ADAMS	TACOMA WA 98409
TK1918	SHIN–ETSU POLYMER AMERICA INC	1181 NORTH 4TH ST	SAN JOSE CA 95112
TK1935	ACCRA–FAB INC	11007 NE 37TH CIRCLE	VANCOUVER WA 98682
TK2430	ZYTEC CORP	1425 EAST BRIDGE ST	REDWOOD FALLS MN 56283
TK2193	PHOTO AND SOUND	820 NW 18TH AVENUE	PORTLAND OR 97209
TK2432	UNION ELECTRIC	15/F #1, FU–SHING N. ROAD	TAIPEI, TAIWAN ROC
TK2500	SOLECTEK ACCESSORIES CORP	6370 NANCY RIDGE DR SUITE 109	SAN DIEGO CA 92121
0JR05	TRIQUEST CORP	3000 LEWIS AND CLARK HWY	VANCOUVER WA 98661–2999
0KBZ5	MORELLIS Q & D PLASTICS	1812 16TH AVE	FOREST GROVE OR 97116
0KB01	STAUFFER SUPPLY	810 SE SHERMAN	PORTLAND OR 97214
00779	AMP INC	2800 FULLING MILL PO BOX 3608	HARRISBURG PA 17105
07416	NELSON NAME PLATE CO	3191 CASITAS	LOS ANGELES CA 90039–2410
18565	CHOMERICS INC	77 DRAGON COURT	WOBURN MA 01801–1039
34416	PARSONS MFG CORP	1055 OBRIAN DR	MENLO PARK CA 94025–1408
52152	MINNESOTA MINING AND MFG CO INDUSTRIAL SPECIALTIES DIV	3M CENTER	ST PAUL MN 55144–0001
6D224	TRI–TEC ENGINEERING CORP	13130 S NORMANDIE	GARDENA CA 90249–2128
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON OR 97077–0001
86928	SEASTROM MFG CO INC	701 SONORA AVE	GLENDALE CA 91201–2431

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	12345	Name & Description	Mfr. Code	Mfr. Part No.
11−1−1	334−8202−00			1		MARKER,IDENT:MKD HANDLE	80009	334820200
−2	390−1109−00			1		CABINET,SCOPE:ALUMINUM,TEK BLUE	TK1935	ORDER BY DESC
−3	367−0289−02			1		HANDLE,CARRYING:13.855,DTT	80009	367028902
−4	212−0144−00			2		SCREW,TPG,TF:8−16 X 0.562 L,PLASTITE	0KB01	ORDER BY DESC
−5	348−0659−00			2		FOOT,CABINET:BLACK POLYURETHANE	0JR05	ORDER BY DESC
−6	−−−−−−−−			1		CABINET,SCOPE:ALUMINUM,TEK BLUE (P/O 390−1109−XX ASSEMBLY)		
−7	348−0764−04			1		SHLD GSKT,ELEK:0.125 X 0.188,WIRE MESH	18565	ORDER BY DESC
−8	334−8324−00			1		MARKER,IDENT:MKD REAR PWR SPLY,WARNING	80009	334832400
−9	334−8322−01	B010100	B020099	1		MARKER,IDENT:MKD OPTION (TDS310/350 ONLY−−OPTION 02 ONLY)	80009	334832201
	334−8322−00	B020100		1		MARKER,IDENT:MKD OPTION (TDS310/350 ONLY−−OPTION 02 ONLY)	80009	334832200
	334−8322−01	B010100	B030099			MARKER,IDENT:MKD OPTION (TDS320 ONLY−−OPTION 02 ONLY)	80009	334832201
	334−8322−00	B030100		1		MARKER,IDENT:MKD OPTION (TDS320 ONLY−−OPTION 02 ONLY)	80009	334832200
	334−8718−00	B020100		1		MARKER,IDENT:MKD OPTION (TDS310/350 ONLY−OPTION 14 ONLY)	80009	334871800
	334−8718−00	B030100		1		MARKER,IDENT:MKD OPTION (TDS310/350 ONLY−OPTION 14 ONLY)	80009	334871800
−10	161−0230−01			1		CABLE ASSY,PWR,:3,18 AWG,92 L,SVT,TAN (STANDARD ACCESSORY)	TK2432	ORDER BY DESC
−11	343−1213−00			1		CLAMP,PWR CORD:POLYMIDE	TK1163	ORDER BY DESC
−12	211−0691−00			4		SCREW,MACHINE:6−32 X 0.625,PNH,STL	0KB01	ORDER BY DESC
−13	200−3971−04	B010100	B020099	1		COVER,REAR:W/FEET AND LABELS (TDS310/350 ONLY)	80009	200397104
	200−3971−05	B020100		1		COVER,REAR:W/FEET AND LABELS (TDS310/350 ONLY)	80009	200397105
	200−3971−04	B010100	B030099	1		COVER,REAR:W/FEET AND LABELS (TDS320 ONLY)	80009	200397104
	200−3971−05	B030100		1		COVER,REAR:W/FEET AND LABELS (TDS320 ONLY)	80009	200397105
−14	211−0730−00			1		SCR,ASSEM WSHR:6−32 X 0.375,PNH,STL CD PL	0KB01	ORDER BY DESC
−15	174−2598−00			1		CA ASSY,SP,ELEC:FRONT PANEL	80009	174259800

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	12345	Name & Description	Mfr. Code	Mfr. Part No.
−16	348−1258−00			4		SHLD,GASKET,ELE:2 LAYER,0.094 X 0.188 X 8.750	80009	348125800
−17	672−1376−00			1		CIRCUIT BD ASSY:FRONT PANEL MODULE	80009	672137600
−18	384−1689−01			6		SHAFT EXTENDER:ACETAL	80009	384168901
−19	020−2036−00			1		ACCESSORIES KIT:KNOBS	80009	020203600
−20	200−3232−00			1		COVER,FRONT:ABS (OPTIONAL ACCESSORY)	TK1908	ORDER BY DESC
−21	334−8323−00			1		MARKER,IDENT:MKD TDS320	80009	334832300
				1		MARKER,IDENT:MKD TDS350	80009	334871900
	334−8719−00			1		MARKER,IDENT:MKD TDS310	80009	334873700
	334−8737−00							
−22	101−0140−00			1		TRIM,DECORATIVE:FRONT	80009	101014000
−23	366−2164−00			14		PUSH BUTTON:SMOKE TAN	80009	366216400
−24	260−2539−00			1		SWITCH SET:BEZEL	TK1918	260−2539−00
−25	259−0086−00			1		FLEX CIRCUIT:BEZEL BUTTON	07416	ORDER BY DESC

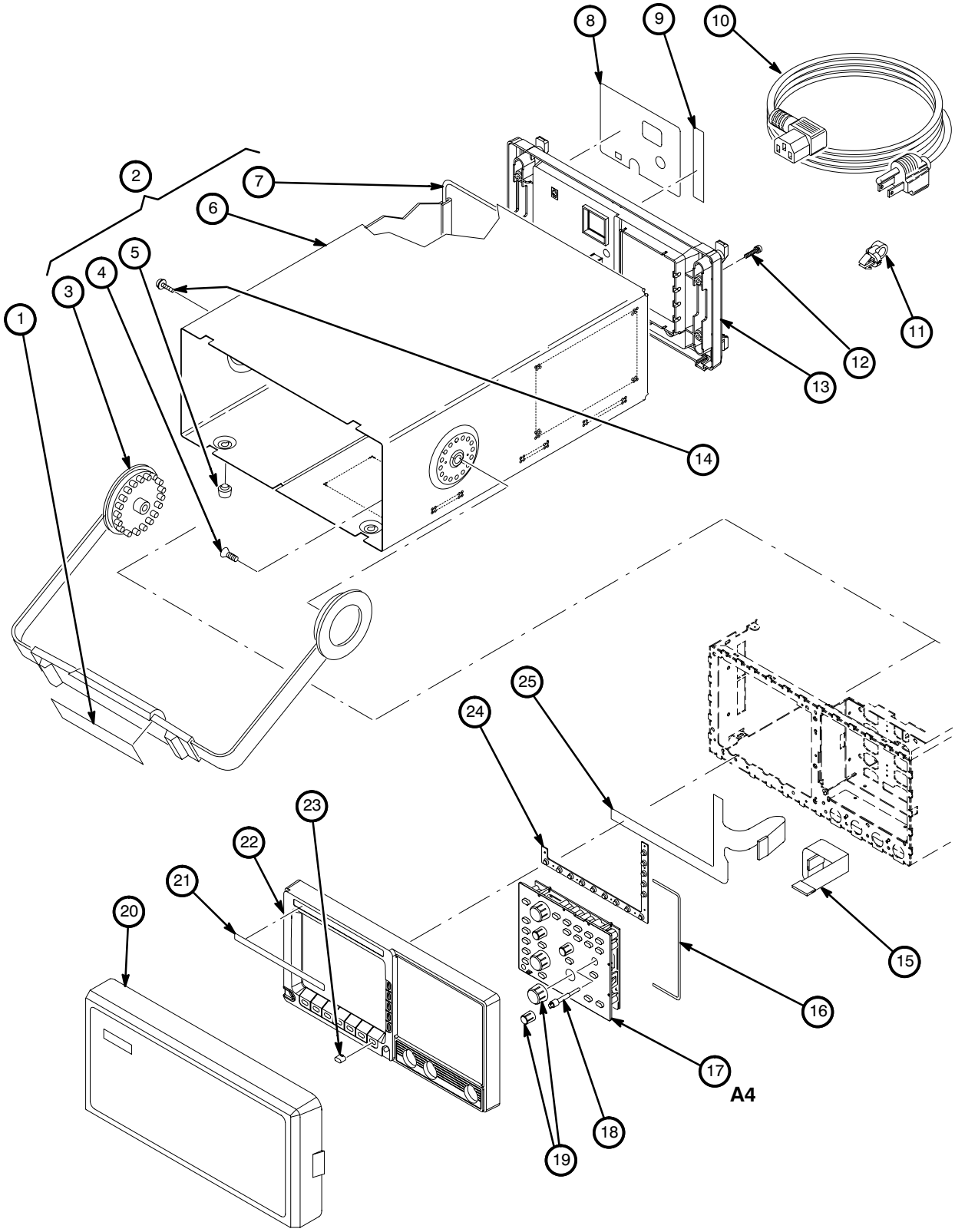


Figure 11-1: Cabinet and Front Panel Assembly

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
11−2−1	426−2436−00	B010100	B020099	1	FRAME,CRT FLTR:POLYCARBONATE (TDS310/350 ONLY)	TK1163	ORDER BY DESC
	426−2436−01	B020100		1	FRAME,CRT FLTR:POLYCARBONATE (TDS310/350 ONLY)	TK1163	ORDER BY DESC
		B010100	B030099	1	FRAME,CRT FLTR:POLYCARBONATE (TDS320 ONLY)	TK1163	ORDER BY DESC
	426−2436−00	B030100		1	FRAME,CRT FLTR:POLYCARBONATE (TDS320 ONLY)	TK1163	ORDER BY DESC
	426−2436−01						
−2	213−0882−00			13	SCREW,TPG,TR:6−32 X 0.437 TAPTITE,PNH,STL	0KB01	ORDER BY DESC
−3	640−0079−01			1	DISPLAY MODULE:7 INCH,480X 640 PIXEL	80009	640007901
−4	426−2426−00			1	FRAME,FAN MTG:POLYCARBONATE	80009	426242600
−5	119−1770−04			1	FAN ASSEMBLY:12VDC,1.72W,35CFM W/CONN	S4246	CUDC12D4
−6	119−5029−01	B010100	B020099	1	POWER SUPPLY:IN 90−280 VAC,45−440HZ,100W (TDS310/350 ONLY)	TK2430	119−5029−01
	119−5029−02	B020100		1	POWER SUPPLY:IN 90−280 VAC,45−440HZ,100W (TDS310/350 ONLY)	TK2430	119−5029−02
		B010100	B030099	1	POWER SUPPLY:IN 90−280 VAC,45−440HZ,100W (TDS320 ONLY)	TK2430	119−5029−01
	119−5029−01	B030100		1	POWER SUPPLY:IN 90−280 VAC,45−440HZ,100W (TDS320 ONLY)	TK2430	119−5029−02
	119−5029−02						
−7	159−0190−00			1	FUSE,CARTRIDGE:5X20MM,3.5A,250V,50MS	TK0946	EQ−3.5A
	159−0277−00			1	FUSE,CARTRIDGE:5X20MM,3A,250V,5SEC	80009	159027700
−8	210−0457−00			1	NUT,PL,ASSEM WA:6−32 X 0.312,STL CD PL	TK0435	ORDER BY DESC
−9	441−1982−00			1	CHASSIS ASSY:ALUMINUM	80009	441198200
−10	210−0056−00			2	WASHER,LOCK:#10 SPLIT,0.047 THK,SI BRZ NP	86928	ORDER BY DESC
−11	213−1079−00			4	JACKSCREW:4−40 X 0.120 INT THD,4−40 X EXT	00779	745563−2
−12	213−1061−00			2	JACKSCREW:GPIB;MALE 6−32 THD 0.32 L	00779	554043−3
−13	407−4196−00			1	BRACKET,STD:ALUMINUM (STANDARD)	80009	407419600
	407−4293−00	B020100		1	BRKT,OPTION:0.050 AL ALLOY (TDS310/350 ONLY−OPTION 14 ONLY)	80009	407429300
		B030100		1	BRKT,OPTION:0.050 AL ALLOY (TDS320 ONLY−OPTION 14 ONLY)	80009	407429300
	407−4293−00						

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	12345	Name & Description	Mfr. Code	Mfr. Part No.
−14	671−2645−00	B010100	B020099	1		CIRCUIT BD ASSY:OPTION (TDS310/350 ONLY−OPTION 14 ONLY)	80009	671264500
		B020100		1		CIRCUIT BD ASSY:OPTION (TDS310/350 ONLY−OPTION 14 ONLY)	80009	672314000
	672−3140−00	B010100	B030099	1		CIRCUIT BD ASSY:OPTION (TDS320 ONLY−OPTION 14 ONLY)	80009	671264500
	671−2645−00	B030100		1		CIRCUIT BD ASSY:OPTION (TDS320 ONLY−OPTION 14 ONLY)	80009	672314000
	672−3140−00							
−15	343−0775−00			2		CLIP,SPR TNSN:	52152	3484−1000
−16	343−0549−00			1		STRAP,TIEDOWN,E:0.098W X 4.0L, ZYTEL	TK1499	HW−047
−17	348−0150−00			1		GROMMET,PLASTIC:DK GRAY,U−SHAPE,0.66 ID	0KBZ5	ORDER BY DESC
−18	174−2598−00			1		CA ASSY,SP:FLAT FLEX,16,26AWG,13.7L	80009	174259800
11−1−19	671−2468−00	B010100	B011094	1		CIRCUIT BD ASSY:MAIN (TDS320 ONLY)	80009	671246800
		B011095	B011103	1		CIRCUIT BD ASSY:MAIN (TDS320 ONLY)	80009	671246801
	671−2468−01	B011104	B011115	1		CIRCUIT BD ASSY:MAIN (TDS320 ONLY)	80009	671246800
	671−2468−00	B011116	B011237	1		CIRCUIT BD ASSY:MAIN (TDS320 ONLY)	80009	671246801
		B011238	B011310	1		CIRCUIT BD ASSY:MAIN (TDS320 ONLY)	80009	671246800
	671−2468−01	B011311	B021867	1		CIRCUIT BD ASSY:MAIN (TDS320 ONLY)	80009	671246801
	671−2468−00	B021868	B032905	1		CIRCUIT BD ASSY:MAIN (TDS320 ONLY)	80009	671318300
		B032905	B034100	1		CIRCUIT BD ASSY:MAIN (TDS320 ONLY)	80009	671318301
	671−2468−01	B034101	B039999	1		CIRCUIT BD ASSY:MAIN (TDS320 ONLY)	80009	671318302
	671−3183−00	B040100		1		CIRCUIT BD ASSY:MAIN (TDS320 ONLY)	80009	671318303
	671−3183−01							
	671−3183−02							
	671−3183−03							

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	12345	Name & Description	Mfr. Code	Mfr. Part No.
	671−3103−00	B010100	B010139	1		CIRCUIT BD ASSY:MAIN (TDS350 ONLY)	80009	671310300
	671−3103−01	B010140	B020099	1		CIRCUIT BD ASSY:MAIN (TDS350 ONLY)	80009	671310301
	671−3103−02	B020100	B031111	1		CIRCUIT BD ASSY:MAIN (TDS350 ONLY)	80009	671310302
	671−3103−03	B031112	B032156	1		CIRCUIT BD ASSY:MAIN (TDS350 ONLY)	80009	671310303
	671−3103−04	B032157	B039999	1		CIRCUIT BD ASSY:MAIN (TDS350 ONLY)	80009	671310304
	671−3103−05	B040100		1		CIRCUIT BD ASSY:MAIN (TDS350 ONLY)	80009	671310305
	671−3178−00	B010140	B020099	1		CIRCUIT BD ASSY:MAIN (TDS310 ONLY)	80009	671317800
	671−3178−01	B020100	B030133	1		CIRCUIT BD ASSY:MAIN (TDS310 ONLY)	80009	671317801
	671−3178−02	3030134	B032130	1		CIRCUIT BD ASSY:MAIN (TDS310 ONLY)	80009	671317802
	671−3178−03	B032131	B039999	1		CIRCUIT BD ASSY:MAIN (TDS310 ONLY)	80009	671317803
	671−3178−04	B040100		1		CIRCUIT BD ASSY:MAIN (TDS310 ONLY)	80009	671317804
−20	407−4247−00			1		BRACKET:ALUMINUM	80009	407424700

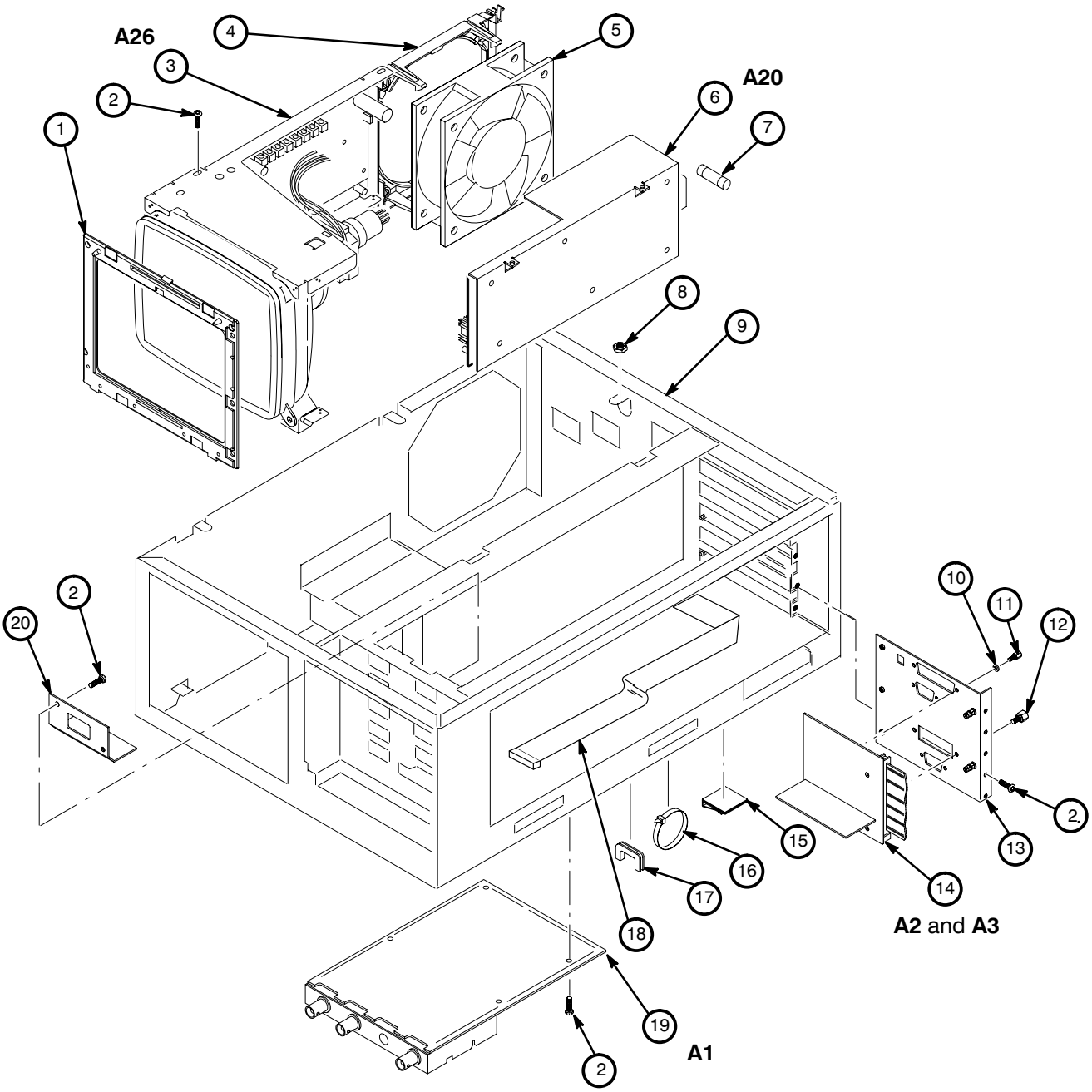


Figure 11-2: CRT, Power Supply, and Circuit Boards

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	12345	Name & Description	Mfr. Code	Mfr. Part No.
						STANDARD ACCESSORIES		
11−3−1	161−0104−05			1		CABLE ASSY,PWR,:3,18 AWG,240V,98.0 L, (OPTION A3−AUSTRALIAN)	S3109	SAA/3−OD3CCFC3X
−2	161−0104−06			1		CABLE ASSY,PWR,:3 X 0.75MM SQ,220V,98.0 L (OPTION A1−EUROPEAN)	S3109	VIIGSOPO−HO5VVF
−3	161−0104−07			1		CABLE ASSY,PWR,:3,1.0MM SQ,240 VOLT,2.5 M (OPTION A2−UNITED KINGDOM)	S3109	ORDER BY DESC
−4	161−0104−08			1		CABLE ASSY,PWR,:3,18 AWG,98 L,SVT,GREY/BLK (OPTION A4−NORTH AMERICAN)	S3109	ORDER BY DESC
−5	161−0167−00			1		CABLE ASSY,PWR,:3.0 X 0.75,6A,240V,2.5M L (OPTION A5−SWITZERLAND)	S3109	ORDER BY DESC
	−−−−−−−−			1		CABLE ASSY,PWR,:3,18 AWG,92 L,SVT,TAN (STANDARD, SEE FIGURE 11−1−10)		
	−−−−−−−−			1		ACCY PKG:(2) P6109B 2M PROBES W/ACCY (TDS310/320 ONLY)		
	−−−−−−−−			1		ACCY PKG:(2) P6111B PASSIVE PROBES W/ACCY (TDS350 ONLY)		
	070−8568−04			1		MANUAL,TECH:INSTRUCTION	80009	070856804
	070−8569−03			1		MANUAL,TECH:QUICK REF CARD	80009	070856903
	070−8690−01			1		MANUAL,TECH:USER,XYZ OF OSCILLOSCOPE	80009	070869001

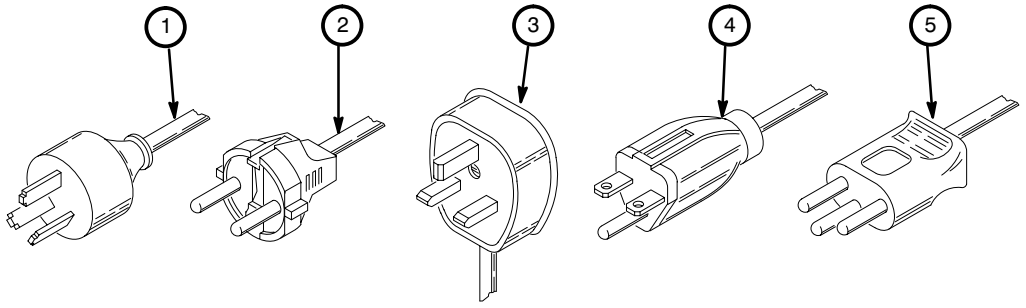


Figure 11-3: Accessories

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Dscont	Qty	12345	Name & Description	Mfr. Code	Mfr. Part No.
						OPTIONAL ACCESSORIES		
	012−0991−00			1		CABLE,COMPOSITE:IDC,GPIB:2 METER	00779	553577−3
	012−0991−01			1		CABLE,GPIB:LOW EMI,1 METER	00779	553577−2
	012−1241−00			1		CA ASSY, INTCON:SHLD CMPST,RS−232,9,,180 L	6D224	012−1241−00
	012−1250−00			1		CABLE,INTCON:SHLD CMPST,PARA CENTRONIC	TK2193	CACC 3049
	012−1298−00			1		CABLE,INTCON:RS232C SERIAL,9 FEET	TK2500	C294−9
	012−1379−00			1		CABLE ASSY:RS232,;76.0 L,9,24 AWG	80009	012137900
	012−1380−00			1		CABLE ASSY:RS232,;76.0 L,9,24 AWG	80009	012138000
	016−0792−01			1		CASE,CARRYING:24.5 X 16.5 X 11.5	34416	2416BE11
	016−1154−00			1		HOOD ASSEMBLY:	80009	016115400
	016−1157−00			1		CASE,CARRYING:26 X 22 X 12,HARD TRANSFER	34416	ORDER BY DESC
	016−1158−00			1		CASE,CARRYING:SOFT PADDED,OPTIONS	80009	016115800
	016−1159−00			1		POUCH:POUCH & PLATE,GPS SIZE	80009	016115900
	016−1166−00			1		RACKMOUNT KIT:	80009	016116600
	070−8571−04			1		MANUAL,TECH:PROGRAMMER	80009	070857104
	070−8722−02			1		MANUAL,TECH:INSTRUCTION, OPT 3P	80009	070872202
	−−−−−−−−			1		COVER,FRONT:ABS (SEE FIGURE 11−1−20)		

Glossary

Glossary

AC Coupling

A mode that blocks the DC component of a signal but passes the dynamic (AC) component of the signal. Useful for observing an AC signal that is normally riding on a DC signal.

Acquisition

The process of sampling signals from input channels, digitizing the samples, processing the results into data points and assembling the data points into a waveform record. The waveform record is stored in memory.

Active Cursor

The cursor that moves when you turn the **General Purpose Knob**. The @ readout on the display shows the position of the active cursor.

Aliasing

A false representation of a signal due to insufficient sampling of high frequencies or fast transitions. A condition that occurs when an oscilloscope digitizes at an effective sampling rate that is too slow to reproduce the input signal. The waveform displayed on the oscilloscope may have a lower frequency than the actual input signal.

Area

Measurement of the waveform area taken over the entire waveform or the gated region. Expressed in volt-seconds. Area above ground is positive; area below ground is negative.

Attenuation

The degree the amplitude of a signal is reduced when it passes through an attenuating device such as a probe or attenuator, that is, the ratio of the input measure to the output measure. For example, a 10X probe attenuates, or reduces, the input voltage of a signal by a factor of 10.

Auto Trigger Mode

A trigger mode that causes the oscilloscope to automatically acquire if it does not detect a triggerable event.

Autoset

A function of the oscilloscope that automatically produces a stable waveform of usable size. Autoset sets up front-panel controls based on the characteristics of the active waveform. A successful autoset sets the volts per division, time per division, and trigger level to produce a coherent and stable waveform display.

Average Acquisition Mode

In this mode the oscilloscope acquires and displays a waveform that is the averaged result of several acquisitions. This reduces the apparent noise. The oscilloscope acquires data as in the sample mode and then averages it according to a specified number of averages.

Burst width
A timing measurement of the duration of a burst.

Cursors
Paired markers that you can use to make measurements between two waveform locations. The oscilloscope displays the values (expressed in volts or time) of the position of the active cursor and the distance between the two cursors.

Cycle Mean
An amplitude (voltage) measurement of the arithmetic mean over one cycle.

Cycle RMS
The true Root Mean Square voltage over one cycle.

DC Coupling
A mode that passes both AC and DC signal components to the circuit. Available for both the trigger system and the vertical system.

Digitizing
The process of converting a continuous analog signal such as a waveform to a set of discrete numbers representing the amplitude of the signal at specific points in time.

Edge Trigger
Triggering occurs when the oscilloscope detects the source passing through a specified voltage level in a specified direction (the trigger slope).

Envelope Acquisition Mode
A mode in which the oscilloscope acquires and displays a waveform that shows the variation extremes of several acquisitions.

Gated Measurements
A feature that lets you limit automated measurements to a specified portion of the waveform. You define the area of interest using the vertical cursors.

GPIB (General Purpose Interface Bus)
An interconnection bus and protocol that allows you to connect multiple instruments in a network under the control of a controller. Also known as IEEE 488 bus. It transfers data with eight parallel data lines, five control lines, and three handshake lines.

Ground (GND) Coupling
Coupling option that disconnects the input signal from the vertical system.

Hard Copy
An electronic copy of the display in a format useable by a printer or plotter.

High

The value used as 100% in automated measurements (whenever the oscilloscope needs high ref, mid ref, and low ref values, as in fall time and rise time measurements). May be calculated using either the min/max or the histogram method. With the min/max method (most useful for general waveforms), it is the maximum value found. With the histogram method (most useful for pulses), it refers to the most common value found above the mid point.

Holdoff, Trigger

A specified amount of time after a trigger signal that elapses before the trigger circuit will accept another trigger signal. This helps ensure a stable display.

Horizontal Bar Cursors

The two horizontal bars that you position to measure the voltage parameters of a waveform. The oscilloscope displays the value of the active (moveable) cursor with respect to ground and the voltage value between the bars.

Low

The value used as 0% in automated measurements (whenever the oscilloscope needs high ref, mid ref, and low ref values, as in fall time and rise time measurements). May be calculated using either the min/max or the histogram method. With the min/max method (most useful for general waveforms), it is the minimum value found. With the histogram method (most useful for pulses), it refers to the most common value found below the mid point.

Main Menu

A group of related controls for a major oscilloscope function that the oscilloscope displays across the bottom of the screen.

Main Menu Buttons

Bezel buttons under the main menu display. They allow you to select items in the main menu.

Maximum

Amplitude (voltage) measurement of the maximum amplitude. Typically the most positive peak voltage.

Mean

Amplitude (voltage) measurement of the arithmetic mean over the entire waveform.

Minimum

Amplitude (voltage) measurement of the minimum amplitude. Typically the most negative peak voltage.

Negative Duty Cycle

A timing measurement representing the ratio of the negative pulse width to the signal period, expressed as a percentage.

Negative Overshoot Measurement

Amplitude (voltage) measurement.

$$NegativeOvershoot = \frac{Low - Min}{Amplitude} \times 100\%$$

Negative Width

A timing measurement of the distance (time) between two amplitude points — falling-edge *MidRef* (default 50%) and rising-edge *MidRef* (default 50%) — on a negative pulse.

Normal Trigger Mode

A mode on which the oscilloscope does not acquire a waveform record unless a valid trigger event occurs. It waits for a valid trigger event before acquiring waveform data.

Pixel

A visible point on the display. The oscilloscope display is 640 pixels wide by 480 pixels high.

Pop-Up Menu

A submenu of a main menu. Pop-up menus temporarily occupy part of the waveform display area and present additional choices associated with the main menu selection. You can cycle through the options in a pop-up menu by repeatedly pressing the main menu button underneath the pop-up.

Positive Duty Cycle

A timing measurement of the ratio of the positive pulse width to the signal period, expressed as a percentage.

Positive Overshoot

Amplitude (voltage) measurement.

$$Positive\ \ Overshoot = \frac{Max–High}{Amplitude} \times 100\%$$

Positive Width

A timing measurement of the distance (time) between two amplitude points — rising-edge *MidRef* (default 50%) and falling-edge *MidRef* (default 50%) — on a positive pulse.

Pretrigger

The specified portion of the waveform record that contains data acquired before the trigger event.

Real-Time Sampling

A sampling mode where the oscilloscope samples fast enough to completely fill a waveform record from a single trigger event. Use real-time sampling to capture single-shot or transient events.

Record Length

The specified number of samples in a waveform.

Reference Memory

Memory in an oscilloscope used to store waveforms or settings. You can use that waveform data later for processing. The oscilloscope saves the data even if you turn it off or unplug it.

Roll

An acquisition mode useful at slow horizontal scale settings. Roll mode allows you to view the waveform as it is acquired point-by-point. The waveform appears to roll across the display.

Sample Acquisition Mode

The oscilloscope creates a record point by saving the first sample during each acquisition interval. This is the default mode of the acquisition system.

Sample Interval

The time interval between successive samples in a time base. For real-time digitizers, the sample interval is the reciprocal of the sample rate. For equivalent-time digitizers, the time interval between successive samples represents equivalent time, not real time.

Sampling

The process of capturing an analog input, such as a voltage, at a discrete point in time and holding it constant so that it can be quantized. Two general methods of sampling are: *real-time sampling* and *equivalent-time sampling.*

Selected Waveform

The waveform on which all measurements are performed, and which is affected by vertical position and scale adjustments. The light next to one of the channel selector buttons indicates the current selected waveform.

Side Menu

Menu that appears to the right of the display. These selections expand on main menu selections.

Side Menu Buttons

Bezel buttons to the right of the side menu display. They allow you to select items in the side menu.

Signal Path Compensation (SPC)

The ability of the oscilloscope to minimize the electrical offsets in the vertical, horizontal, and trigger amplifiers caused by ambient temperature changes and component aging. You should run SPC at the following times: when the ambient temperature varies more than 5° C from the last SPC, when using settings equal to or less than 5 mV per division, and when performing critical measurements.

Tek Secure

This feature erases all waveform and setup memory locations (setup memories are replaced with the factory setup). Then it checks each location to verify erasure. This feature is useful where the oscilloscope is used to gather security sensitive data.

Time base

The set of parameters that let you define the time and horizontal axis attributes of a waveform record. The time base determines when and how long to acquire record points.

Vertical Bar Cursors

The two vertical bars you position to measure the time parameter of a waveform record. The oscilloscope displays the value of the active (moveable) cursor with respect to trigger and the time value between the bars.

XY Format

A display format that compares the voltage level of two waveform records point by point. It is useful for studying phase relationships between two waveforms.

YT Format

The conventional oscilloscope display format. It shows the voltage of a waveform record (on the vertical axis) as it varies over time (on the horizontal axis).

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